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- "abstract" en Anglais, précédé du titre en Anglais.
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(suite sur la 3e page de couverture)

P. 3966 Museum

Ce volume est dédié
à la mémoire d'Albert LUCAS
(1928-1995)
Professeur à l'Université de Bretagne occidentale
Membre fondateur et premier Président
de la Société Française de Malacologie

BIBL. DU MUSÉUM PARIS

Performance of triploid Pacific Oysters *Crassostrea gigas* (Thunberg) reared in high carrying capacity ecosystem: survival, growth and proximate biochemical composition

Philippe GOULLETQUER [1], Jean-Pierre JOLY [1], André GÉRARD [2] Eric LE GAGNEUR [1], Jacques MORICEAU [1], Jean-Marie PEIGNON [2], Serge HEURTEBISE [2] and Pascal PHELIPOT [2]*

RÉSUMÉ

Performances de croissance d'huîtres creuses triploïdes *Crassostrea gigas* (Thunberg) élevées dans un système à capacité trophique élevée: taux de survie, croissance et composition biochimique

Des huîtres creuses triploïdes *Crassostrea gigas* ont été produites en 1990 au moyen d'un traitement des oeufs fertilisés à la cytochalasine B (CB). Ces lots d'huîtres triploïdes, ainsi que des huîtres traitées mais restées diploïdes, et des diploïdes témoins (non traités) de la même origine ont été mis en élevage dans la Baie des Veys qui représente un écosystème à capacité trophique élevée (Côte est Cotentin, Normandie). Un suivi mensuel des différents lots en 1992 a montré des performances de croissance et un engraissement supérieurs chez les triploïdes par rapport aux diploïdes avec cependant une hétérogénéité de croissance également supérieure. A la fin du cycle d'élevage de 26 mois, aucune fréquence de distribution bimodale, pouvant résulter d'une différence entre triploïdes obtenus en méiose I et II, des variables 'taille' et 'poids' n'a pu être observés. Les huîtres triploïdes ont présenté une gamétogénèse retardée. Les teneurs élevées en sucres chez les huîtres triploïdes ont présenté une faible variabilité autour de 40% de juin à septembre. Leurs taux de survie ont été inférieurs à ceux de la population témoin diploïde. Par ailleurs, les huîtres réfractaires au traitement à la cytochalasine B, et donc restées diploïdes, ont été plus sensibles aux facteurs de stress environnementaux indiquant ainsi un effet à long terme du traitement. Par conséquent, il apparaît important d'améliorer la méthode d'induction afin de maximiser le taux de triploïdie et de survie à long terme. A partir des informations obtenues, il apparait important de compléter les tests in-situ dans des écosystèmes pouvant présenter des facteurs de stress plus importants, en particulier dans des milieux à faible capacité trophique.

ABSTRACT

Triploid oysters *Crassostrea gigas* were produced in 1990 by treating fertilized eggs with cytochalasin B (CB). Triploids, treated diploids, and controls were deployed early 1991 in a high carrying capacity ecosystem on the Eastern Coast of Normandy (France). A monthly monitoring in 1992 showed that triploids yielded significantly higher growth rate and biochemical composition. However, growth was more heterogeneous. No evidence was found for a length or weight bimodal frequency distribution within triploid groups after a 26 months rearing cycle. Triploids showed retardation of gametogenesis. Carbohydrates content in triploids remained almost constant (40%) from June to September. Their survival rates were significantly lower than controls. Moreover treated diploids were found more sensitive to environmental conditions than controls, demonstrating long term CB effect on oysters. Therefore, the method of induction should be improved to maximize triploidy and long term survival rates. We recommend further field testings to assess triploid response to stressful environmental conditions, particularly in low carrying capacity ecosystems.

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INTRODUCTION

Extensive literature is now available regarding ploidy manipulation in molluscan shellfish (for review, see Beaumont and Fairbrother, 1991). Triploidy has been studied in several species including the Pacific oyster *C. gigas* and the Eastern oyster *C. virginica* (Stanley *et al.*, 1981). Ploidy manipulation is usually considered as a method for enhancing production. However, few studies analyzed oyster production over a full rearing cycle, and most of them have focused on yearlings (Allen and Downing, 1986; Akashige and Fushimi, 1992). Since oyster reproduction effort increases with age and is affected by triploidy, it seems of particular interest to study their production over the entire rearing cycle. Moreover, only few studies considered environmental constraints on genetically manipulated species (Shpigel *et al.*, 1992). Therefore, triploid oyster production is almost unpredictable prior to field testing.

Oyster culture is widely practised along the French coastline, from the English Channel (Normandy) to Mediterranean lagoons. Therefore, oysters face various environmental conditions affecting their physiological activity and growth rate. By way of example, natural spatfall occurs only in the southwest part of France. Before full-scale culture using genetically manipulated shellfish, it appears critical to test their physiological capacity and survival rate in various ecosystems. Besides survival rate, and from a management point of view, cohort homogeneity is also of particular interest for oyster farmers.

The present study was undertaken to determine (1) productivity of triploid oysters at two levels of stocking density in a high carrying capacity ecosystem, and (2) a possible length or weight bimodal frequency distribution resulting from triploids created during the meiosis I and meiosis II, and (3) the effect of the biochemical treatment on diploid growth. The overall objective is to assess the commercial feasibility based upon triploid oyster production.

MATERIALS AND METHODS

Oysters used in this field study were produced as part of a comprehensive cytogenetic research program aiming to develop new methodologies and improve three species, the Manila clam *Tapes philippinarum*, the flat oyster *Ostrea edulis* and the Pacific cupped oyster *Crassostrea gigas* (Dufy and Diter, 1990; Desrosiers *et al.*, 1994; Gérard *et al.*, 1993).

C. gigas broodstock was conditioned at IFREMER's research hatchery facility (URGE), Ronce-les-Bains (France). Triploids and diploids were produced from the same mass spawn on July 5, 1990. Triploidy was induced by treating eggs at 25°C with 0.5 mg.l^{-1} cytochalasin B (CB) dissolved in DMSO (1 mg.l^{-1}) for 20mm, beginning 15mm after fertilization. Methodology was derived from the protocol of Downing and Allen (1987). After settlement (day 25th), spat from the CB treated groups were assayed by image cytometry (Gérard *et al.*, 1991) and found to contain 66% triploids. Oysters were maintained in nursery and fed with mixed phytoplankton culture.

On March 19, 1991, oysters (triploids averaging 2.33 g and diploids 2.63 g) were randomly selected and equally deployed in oyster bags within the intertidal area of two sites located on the Eastern Coast of Normandy: Ste Marie du Mont (site 1) and Bays of Veys (site 2), shellfish cultured areas characterized by a low (1,500 metric tons) and high (10,000 tons) stocking density respectively (Kopp *et al.*, 1991; Jeanneret *et al.*, 1992) (Fig. 1). Moreover, this area is characterized by low summer temperature (T°=17°- 20°C) impeding intensive natural spatfall.

In 1992, experimental populations were sampled on a monthly basis. Length and total weight were measured individually on 30 animals to the nearest mm and 0.01 g respectively. Relative survival rate was estimated by counting dead animals. Oysters were shucked and a piece of gill removed for ploidy control by image cytometry (Gérard *et al.*, 1991). The remainder of each oyster was stored at -60°C, then freeze-dried 36 hours before weighing whole dry meat. Proximate biochemical composition was estimated using 10 mg of freeze dried homogenate. Lipids were extracted, purified and then analyzed according to Marsh and Weinstein (1966), and Bligh and Dyer (1959). Carbohydrates and glycogen analysis followed the procedure of Dubois *et al.* (1956).

Three groups were defined for data treatment based upon ploidy levels: triploids (3N), CB treated diploids (2N), and diploids (control).

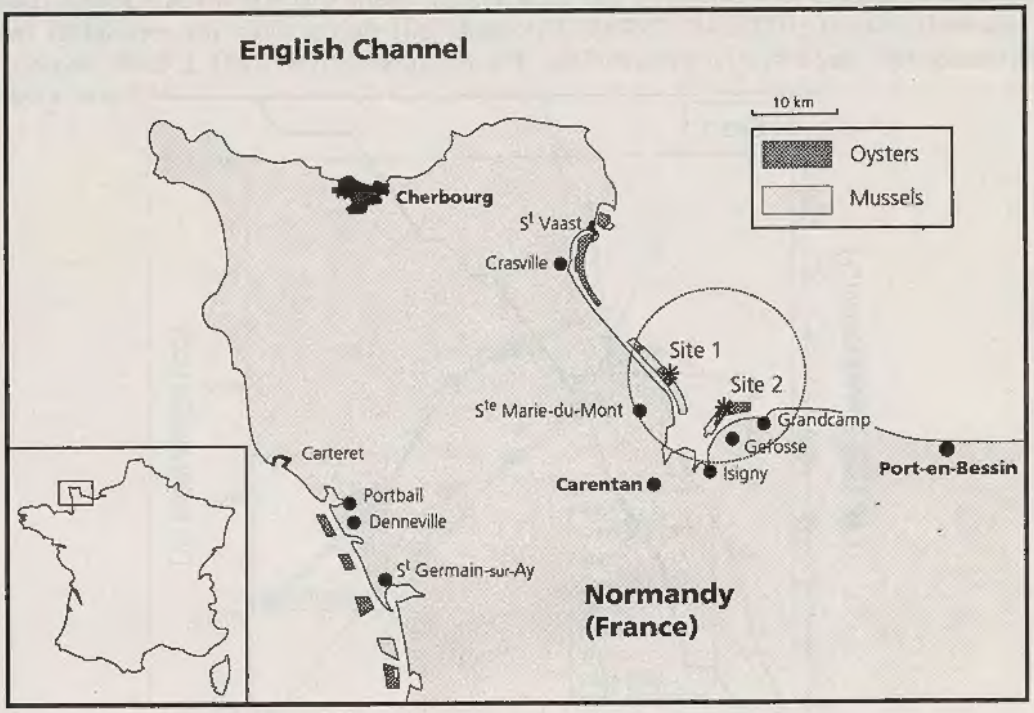

Figure 1. Geographic distribution of the experimental sites.

RESULTS

Survival

We estimated the proportion of triploids in the spat prior to field deployment; 66% of the sampled spat were triploid in 1990. After a 26 month rearing cycle, a sub-sample showed that 53.6% and 70% of treated animals were triploids on site 1 and 2 respectively. A Chi-square test was performed on data resulting from the 1992 monthly monitoring on site 1. There was no significant difference in triploid proportion over the course of the experiment (χ^2=3.42, d.f.=5, P>0.05). None of the 62 controls were triploid. Similar tests on the survival rate of the treated and controlled populations estimated by field counting showed significant differences (2 x 2 contingency χ^2=31.41, P<0.0001, site 1; χ^2=9.07, P<0.001, site 2). Survival rates of controls were significantly higher than treated populations (i.e., site 1: 68.9% vs 48.6%, site 2: 87.1% vs 73.8%).

Growth

Distribution fitting

Analysis of total weight frequencies did not reveal a bimodal distribution within the triploid group, in spite of the 26 months life span. Cumulative frequencies revealed distribution patterns among treated, controlled diploids and triploids (Fig. 2). The lowest slope coefficients were observed for both triploid groups, demonstrating growth heterogeneity. Negative Skewness and Kurtosis coefficients characterized treated diploids on both sites (i.e., site 1: -0.15, -1.41; site 2: -0.32, -1.35) and indicated a distribution trend toward a flat curve with short tails, and the lower tail longer than the upper. Controlled populations showed positive values for both coefficients (i.e., site 1: 0.45, 0.31; site 2: 0.39, 0.12) describing a steep distribution at the center and upper tail longer than the lower. Regarding triploids, the distribution tended to a flat curve with the upper

longer than the lower tail (i.e., site 1: 0.69, -0.41; site 2: 0.52, -0.30). However, assumption of normal distribution was still valid in all cases to allow parametric testing since standardized coefficients were within the range -2.0 to +2.0.

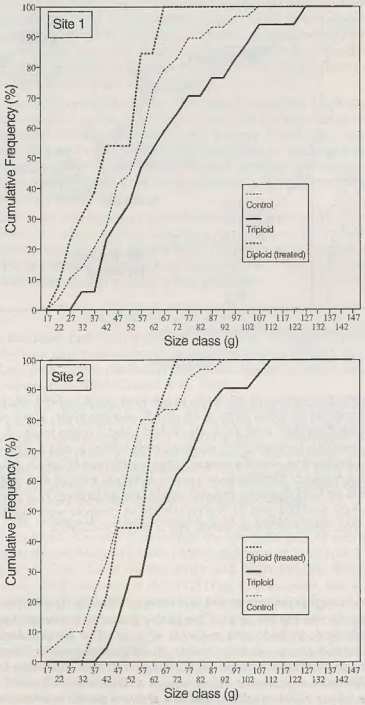

Figure 2. Cumulative oyster total weight frequency (%) for control, diploids, and triploids.

Site effect

No significant difference in length or total weight was noted between sites within each group. In contrast, ANCOVA for the dry meat weight with the oyster length as a covariate estimated significant difference for each group (i.e., triploids, F=73.7, P<0.0001; treated diploids, F=5.7, P<0.05; controls, F=67.2, P<0.0001). Overall growth performance on site 1 was significantly greater than those on site 2.

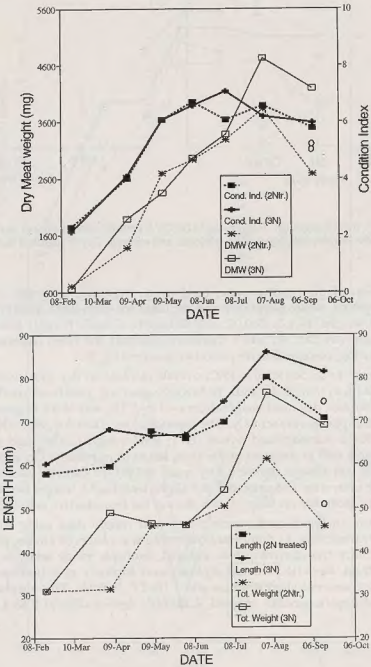

Figure 3. Comparison of mean oyster length (mm), total weight (g), dry meat weight (mg) (3A), and condition index (3B) between control (O), 2N treated, and 3N over the sampling period on site 1.

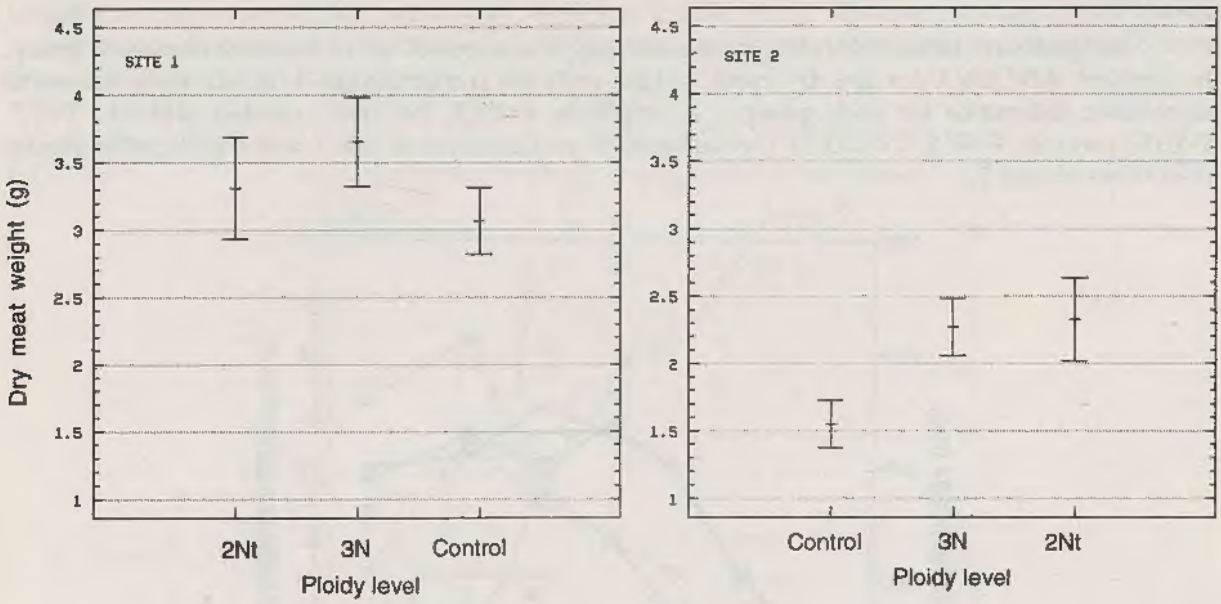

Figure 4. Oyster dry meat weight (g) comparison (ANCOVA results, mean ± SE) on september data on both sites. Ploidy level: 2Nt = treated diploids; 3N = triploids, and control). Oyster length is the covariate.

Ploidy effect

After completion of the rearing cycle, total oyster weight and length were significantly different among triploids, treated diploids and diploids for both sites (ANOVA: site 1, length, $F=3.5$, $P<0.05$; total weight, $F=4.4$, $P<0.02$; site 2, length, $F=6.35$, $P<0.01$; total weight, $F=7.57$, $P<0.002$). Monthly growth data on site 1 demonstrated that the main difference, favoring the triploids, occurred during the reproductive period in summer (Fig. 3).

From 18 February to 15 September 1992, overall increase in dry meat weight was 637% in triploids, and only 381% in treated diploids. Following spawning, which occurred at site 1 between 3 August and 15 September, dry meat weight decreased by 9.1%, and 14.4% of pre-spawn weight for treated diploids and diploids respectively. The reproductive effort for triploids reached 3.9% of pre-spawn weight for a standardized oyster (65 g total weight). Although initiated, triploid spawning was probably still in progress at the completion of our study. On site 2, spawning was retarded for triploids and treated diploids. Dry meat weight for controls declined by 42.3%. We should also note for both sites in September the slight length and weight decrease which might result from a selective mortality on large oysters during the reproductive activity.

Ploidy effect was analyzed on September dry meat weight data using ANCOVA with the oyster length as a covariate (Fig. 4). Significant difference was observed among ploidy level on site 2 ($F=8.3$, $P<0.001$). Since the spawning was delayed, multiple range analysis, based upon the Newman-Keuls method, classified treated diploids and triploids as a homogeneous group. In contrast, ploidy effect was not significant on site 1 ($F=2.0$, $P=0.14$). This resulted from the high post-spawning variability (mean±SD: triploid, 4.18±2.07; treated diploid 2.68 ±1.03, diploid 3.04 ±1.27g).

Proximate biochemical composition

Triploids, and diploids with treated diploids, showed different patterns of utilization of carbohydrates, glycogen and to a lower extent, lipids. Carbohydrate storage occurred until early July when it reached a record high of 42% for diploids and triploids (Fig. 5). Thereafter a steadily decline was noted for controls and treated diploids until pre-spawning (29.7%). In contrast, carbohydrates content for triploids remained constant around 40%. A similar pattern was noted for

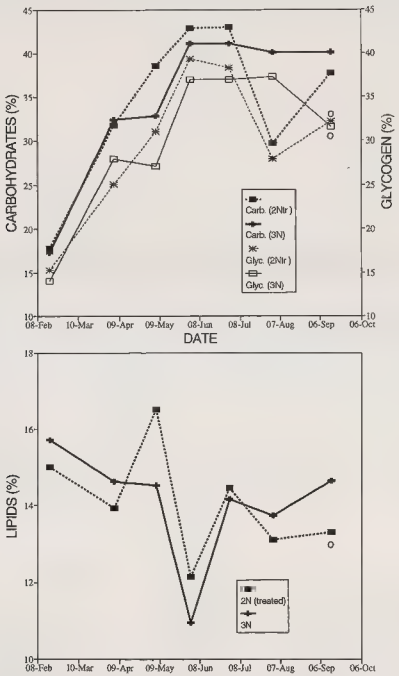

Figure 5. Comparison of oyster proximate biochemical composition: carbohydrates (%), glycogen (%) (5A), and lipids (%) (5B) over the sampling period (site 1). Control (O), 2N treated, and 3N.

glycogen until August. Then, glycogen declined slightly in September with a concomitant lipid increase, indicating gametogenesis activity. Carbohydrates and glycogen increased in diploids after spawning while lipids increased and carbohydrates decreased in triploids (Fig. 5).

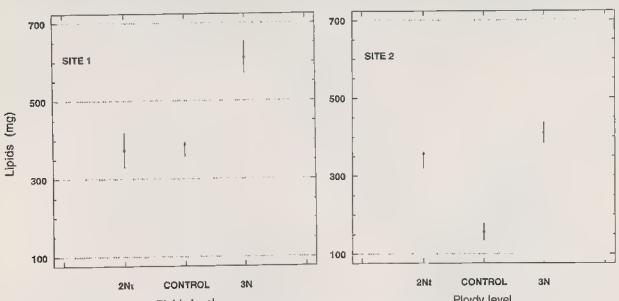

Figure 6. Comparison of lipids content (mg) (ANCOVA results, mean 95% confidence intervals) on september data on both sites Ploidy level· 2Nt = treated diploids, 3N = triploids, and control Oyster dry meat weight is the covariate

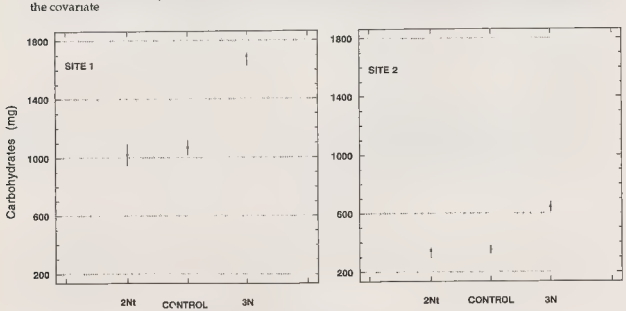

Figure 7. Comparison of carbohydrates content (mg) (ANCOVA results, mean 95% confidence intervals) on september data on both sites. Ploidy level: 2Nt = treated diploids; 3N = triploids, and control. Oyster dry meat weight is the covariate.

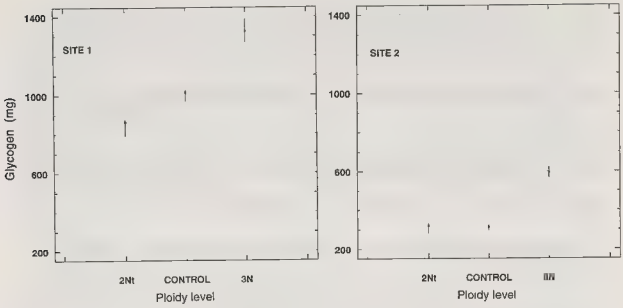

Figure 8 Comparison of glycogen content (mg) (ANCOVA results, mean 95% confidence intervals) on september data on both sites Ploidy level 2Nt = treated diploids, 3N – triploids, and control Oyster dry meat weight is the covariate

ANCOVAs with the dry meat weight as a covariate were performed on September data (Fig. 6,7,8). On site 1, significant differences were observed among ploidy groups regarding lipids ($F=3.25$, $P<0.05$) (Fig. 6) and carbohydrates ($F=8.1$, $P<0.001$) (Fig 7). For both variables, treated diploids and controls were significantly lower than triploids. Since glycogen concentration increased in the post-spawning period in diploids and treated diploids, and triploids had the opposite trend, no significant difference was noted among groups ($F=1.75$, $P=0.18$). Similar ANCOVAs on site 2 were significant in all cases (lipids, $F=4.03$, $P<0.005$; carbohydrates, $F=38.1$, $P<0.0001$; glycogen, $F=40.5$, $P<0.0001$) (Fig. 6,7,8). However, since treated diploid spawning was delayed, average lipid content was homogeneous between treated diploids and triploids (i.e., 356.2 mg, 410.2 mg) and significantly higher than control mean (i.e., 156.7 mg). Similarly, carbohydrates and glycogen contents were significantly lower in diploids and treated diploids than triploids (351.5 mg, 346.5 mg, 645.2 mg; 311.6 mg, 318.2 mg, 593.1 mg respectively).

DISCUSSION

Allen and Downing (1986) have demonstrated an effective gametogenesis and spawning in triploids. Gonadal development in triploids was retarded and resulted in substantial differences in glycogen content during gametogenesis. In our study, triploids showed also a reproductive activity but neither carbohydrate and glycogen decline during summer. Gametogenesis for treated diploids and controls induced catabolism of energetic reserves, resulting in carbohydrates decline and concomitant lipids increase. The reduced reproductive activity in triploids limited this biochemical pathway (Mathieu and Lubet, 1993). Only a slight decline was noted in September. The particularly high food availability might be responsible for this dissimilarity since glycogen content is regulated by environmental conditions including temperature and food level (Gabbott, 1975). Temperature effects neurosecretory hormones, which control storage tissues and germinal cells (Gabbott, 1975; Lubet and Mathieu, 1978). Moreover, summer temperature in this ecosystem

varies around 17°-20°C, the critical lower limit for *C. gigas* successful spawning (Héral and Deslous-Paoli, 1991). However diploids did spawn. Therefore, we can suggest that triploids are either (1) under the same regulatory control as diploids but their physiological responses might be tied to a different temperature threshold, or (2) a feedback action by the maturing gonad effects the neuroendocrine control of storage tissues (Mathieu and Lubet, 1993).

We have shown that triploids were significantly larger than diploids and treated diploids by the end of the monitoring. This might be explained by the reduced energetic spending for gametogenesis, energy being preferentially used for growth (Allen and Downing, 1986). Reference to heterozygosity has also often been used to explain growth discrepancies (Koehn *et al.*, 1988). Triploid oysters created during the release of the first polar body (Meiosis I) are characterized by higher heterozygosity and would yield enhanced growth, even though this theoretical advantage has not yet convincingly been demonstrated (Stanley *et al.*, 1984, Yamamoto *et al.*, 1988). Li *et al.* (1992) and Jiang *et al.* (1993) on the pearl oyster *Pinctada martensii* and Mason *et al.* (1988) on *Mya arenaria* were unable to establish a positive correlation between triploid heterozygosity and growth.

In our study, triploids were created at both first and second polar releases (Meiosis I & II). CB treatments at first polar body formation may effect larval survival (Downing and Allen, 1987). Since no heterozygosity control was carried out on triploids, it seems difficult to conclude on any relationship. However no expected growth difference within the triploid groups was observed by the end of the experiment. Individual variability, selective mortality, or lacking effect of heterozygosity might be either responsible for this final distribution.

However, we have shown that greater size heterogeneity is a triploid characteristic. Hooker and Morse (1985) and Morse (1984) have suggested that extreme heterogeneity of sizes and growth rates observed in haliotids is not necessarily the result of genetic or nutritional variation, but is likely to reflect inadequate satisfied physiological requirements. By way of example, provision of exogenous peptide hormones reduced size heterogeneity (Morse, 1984). Therefore, overall triploidy results including glycogen metabolism, abnormal reproductivity and size heterogeneity, might be explained by abnormal functioning neurosecretory system, affected by the CB treatment .

Several studies have shown comparable survival rate between diploid controls and triploids (Stanley *et al.*, 1984; Allen and Downing, 1986; Chaiton and Allen, 1985). Allen and Downing (1986) observed higher survival during reproductive activity, and Akashige and Fushimi (1992) reported twice as much survival as control during the resting period. This study is an exception to these findings since treated oyster survivorship is significantly lower. Moreover, no long-term negative effects from cytochalasin B were found on shellfish growth (Downing and Allen, 1987). Since triploidy percentage remained constant during the experiment and survivorship of treated animals was significantly lower, we conclude that treated diploids are more sensitive to environmental conditions than controls This demonstrates a long term CB effect on oysters. Even the recent evidence suggesting there may be some spontaneous chromosome loss in triploids as they age does not counteract these results (Allen, 1993). This is also of particular interest for hatchery production and prompts us to recommend optimization of the methodology to maximize the triploidy rate. Recently, new inductions yielded 95% of triploid using CB (Gérard *et al.*, 1994) Besides, the new chemical inducer 6-DMAP has been already successfully tested, yielding to higher larval survivorship and 85% of triploid (Desrosiers *et al.*, 1993).

The unexpected results of survivorship as well as the higher growth variability in triploids demonstrate the need for further testing in various ecosystems including low carrying capacity environments. This would allow better assessment of triploid sensitivity and performance to stressful environmental conditions, therefore allowing enhancement of oyster production.

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Seuil de production de pseudo-fécès de l'huître creuse du Pacifique: *Crassostrea gigas* (Thunberg) dans des conditions de faibles charges particulaires

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ABSTRACT

Pseudo-faeces production threshold of the Pacific cupped oyster: *Crassostrea gigas* (Thunberg) under low particulate matter concentrations

This study is part of a comprehensive research program focusing on the oyster shellfish management in the Marennes-Oléron Bay. Within this program, a task aimed to develop a biological model of the Pacific cupped oyster *Crassostrea gigas*. Our study addressed the issue of pseudo-faeces production threshold under various diet quality levels. Pseudo-faeces sampling was carried out using particulate matter concentration below 11 mg l^{-1}. The various modalities prompted us to define two pseudo-faeces production models. The first model was developed using natural seawater. The organic matter ratio ranged from 25 to 45% while the pseudo-faeces production threshold reached 2.9 to 4.4 mg l^{-1} of total particulate matter. The second model was established using seawater conditions enriched with algal culture. Within the range of 40 to 80 % of organic matter, the pseudo-faeces production threshold varied from 2.12 to 4.37 mg l^{-1} of the total particulate matter. The pseudo-faeces production threshold was estimated to 1.0 mg l^{-1} of consumed particulate matter.

RÉSUMÉ

Cette étude s'inscrit dans le cadre d'un programme de recherche sur la gestion ostreicole du bassin de Marennes-Oléron. A l'intérieur de ce programme, un des objectifs est de développer le modèle biologique de l'huître *Crassostrea gigas*. Des mesures de production de pseudo-fécès sont réalisées dans des conditions de charges particulaires inférieures à 11mg l^{-1}. Les différentes modalités alimentaires étudiées permettent d'obtenir deux modèles de production de pseudo-fécès complémentaires. Le premier est un modèle basé sur des conditions naturelles d'eau de mer. Dans une gamme de teneur organique de 25 à 45 %, le seuil de production de pseudo-fécès est compris entre 2,90 et 4,40 mg l^{-1} de matière particulaire totale. Le deuxième modèle est un modèle "eau de mer" enrichie en algues de culture. Dans une gamme de teneur organique de 40 à 80 %, le seuil de production de pseudo-fécès est compris entre 2,12 et 4,37 mg l^{-1} de matière particulaire totale. Le seuil de production de pseudo-fécès, en matière particulaire consommée est de 1,0 mg l^{-1} dans le cadre de cette étude.

INTRODUCTION

Les bivalves filtreurs s'alimentent à partir de la matière en suspension dans l'eau de mer dont la valeur nutritionnelle présente de fortes variations (Héral *et al.*, 1980 ; Widdows *et al.*, 1979).

Les études écophysiologiques réalisées depuis de nombreuses années ont été développées à des fins de modélisation des écosystèmes côtiers et la gestion des bassins conchylicoles. Le bassin de Marennes-Oléron constitue un site atelier modèle pour ces études scientifiques (Bacher, 1989; Raillard *et al.*, 1993). Parmi les quelques bivalves filtreurs présents sur ce site, l'huître *Crassostrea*

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gigas est un modèle biologique privilégié en raison de la forte biomasse qu'il représente, de son importance économique dans le bassin et des problèmes d'adéquation entre la capacité trophique et la biomasse en élevage (Héral, 1989). Le modèle huître a été développé afin d'optimiser la gestion du bassin conchylicole, en simulant la physiologie d'une population d'huître, et son impact sur l'écosystème. Ce modèle évolue parallèlement aux connaissances physiologiques acquises sur cette espèce.

Par ailleurs, si l'aquaculture traditionnelle de l'huître demeure de type extensif, l'activité de recherche en génétique et pathologie passe par le contrôle de l'élevage dans des structures intensives où la gestion alimentaire est essentielle (e.g., coût, pollution) (Baud *et al*, 1990). En particulier, l'ajustement de la ration alimentaire aux besoins physiologiques des mollusques est essentiel. La production de pseudo-fécès constitue une perte d'énergie non négligeable dans le bilan énergétique de l'animal et l'optimisation des élevages.

La production de pseudo-fécès est une caractéristique des mollusques filtreurs et constitue un moyen de contrôler l'ingestion de matière en suspension (Newell et Jordan, 1983).

Des études de physiologie ont démontré la capacité des bivalves à exercer une sélection au sein de cette matière ; sélection liée aux caractéristiques physiques de la matière particulaire (e.g., taille, densité) (Atkins, 1937 ; Bernard, 1974), à la qualité de la matière (e.g., organique, type, èspèces) (Foster-Smith, 1975). Parallèlement, des études sont réalisées pour connaître les mécanismes associés à cette sélection. Plusieurs écoles s'affrontent, entre les "mécanistiques" (Jorgensen, 1981) et les "sensoriels", dont Shumway *et al.* (1985) qui considèrent que les mollusques ont une capacité de selection et de tri des espèces d'algues au niveau des palpes labiaux et (ou) de l'estomac.

Chez *Crassostrea gigas*, Razet *et al.* (1990) démontrent le tri organique effectué par l'huître, et Deslous Paoli *et al* (1992), un enrichissement en carbohydrates. Barillé *et al.* (1993) présentent un modèle de sélection basé sur la concentration particulaire sans qu'intervienne la qualité alimentaire.

Très peu d'informations existent sur le seuil de production de pseudo-fécès chez les bivalves. Bayne et Newell (1983) passent en revue les résultats obtenus sur 4 espèces de bivalves. Ce seuil pourrait dépendre du poids du mollusque comme dans le cas de la moule, *Mytilus edulis* (Bayne et Worall, 1980 ; Widdows *et al.*, 1979).

En laboratoire, de nombreuses études ont été réalisées en dessous du seuil de production de pseudo-fécès avec ou sans prise en compte des variations de qualité de la matière particulaire (Bayne et Hawkins 1992 ; Bayne *et al.*, 1987 ; Navarro *et al.*, 1992) . Les études d'écophysiologie dans le bassin de Marennes-Oléron concernent de fortes charges particulaires pouvant atteindre 250 mg l^{-1} (Héral *et al* , 1980) qui induisent de fortes production de pseudo-fécès (Sornin *et al.*, 1983 ; Deslous-Paoli *et al* ,1987). Peu d'études précisent les mécanismes autour du seuil de production de pseudo-fécès, qui devraient permettre d'affiner le modèle huître.

L'objectif de la présente étude est de tester la diversité de l'alimentation sur la production de pseudo-fécès et de préciser le seuil de production de pseudo-fécès à partir d'un ensemble d'expérimentations à faibles charges particulaires. Les conditions testées doivent varier dans une large gamme de pourcentage de matière organique afin de préciser l'effet de la qualité de l'aliment proposé sur la production de pseudo-fécès.

Cette étude précise la notion de qualité dans les processus physiologiques alimentaires de l'huître dans le cadre globale de l'étude du modèle écophysiologique.

MATÉRIELS ET MÉTHODES

Les résultats présentés dans cette étude sont issus d'une série d'expériences de physiologie conduites en laboratoire entre le mois de mai 1991 et mai 1993.

La structure expérimentale mise en oeuvre est présentée sur la figure 1. Les cellules de mesures sont décrites par Barillé *et al.* (1993). Une paroi transversale compartimente la cellule de mesure et permet de collecter d'une part les fècès, et de l'autre, les pseudo-fécès La durée de collecte des biodépots, mesurée précisément pour chaque expérience, est compris entre 1h45 et 2h15.

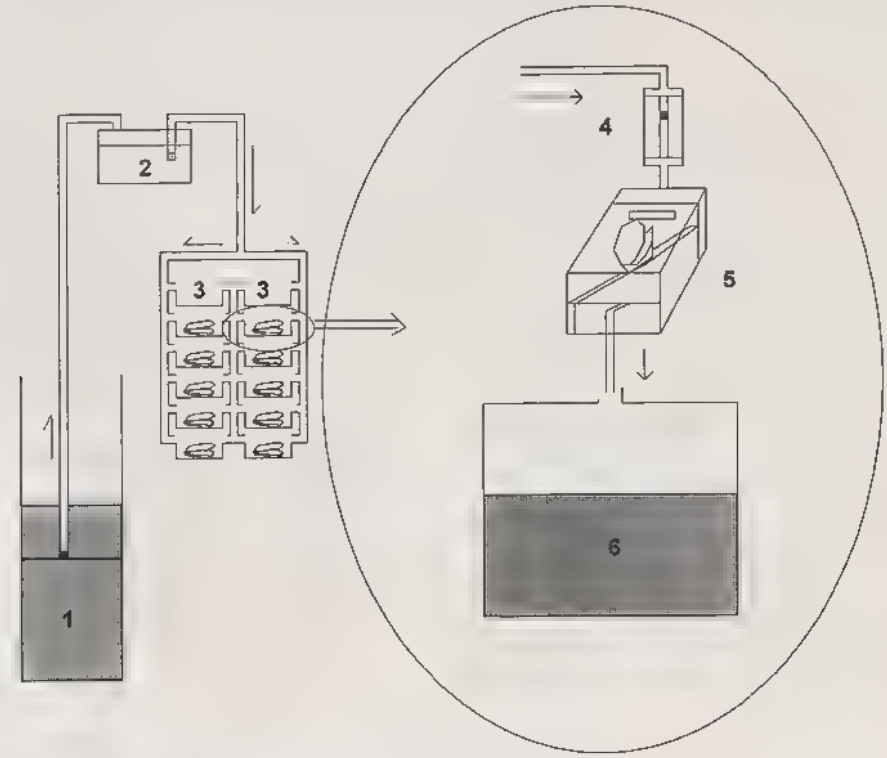

Figure 1 Dispositif experimental 1 approvisionement en algues *Tetraselmis suecica* , 2 bac d'homogénéisation; 3 cellules témoins; 4 débitmètre, 5 cellule de mesure; 6 sortie

Les huîtres d'un poids sec de chair de 0,5 à 1,2 g sont issues du bassin de Marennes-Oléron. Toutes les mesures physiologiques sont réalisées dans les 24 heures qui suivent la collecte des huîtres afin d'éviter toute évolution des réponses physiologiques (Widdows *et al.*, 1975). Les mesures sont réalisées simultanément sur 10 à 15 huîtres naturellement adaptées aux conditions environnementales saisonnières (Bayne *et al.*, 1993).

Dans le protocole expérimental, l'eau de mer est directement pompée dans le milieu naturel et les mesures réalisées entre 13°C et 20°C. Plusieurs types alimentaires sont distribués afin d'estimer l'effet qualité et quantité sur la production de pseudo-fécès chez *Crassostrea gigas*. Le tableau 1 présente les 5 classes de conditions alimentaires : eau de mer naturelle (condition 1) ; eau de mer filtrée avec apport de *Tetraselmis suecica* (condition 2) ; eau de mer et apport de *Skeletonema costatum* (condition 3), eau de mer et *Isochrysis* (condition 4), eau de mer et mélange de *Tetraselmis* et de *Thalassiosira pseudonana* (condition 5) Les algues associées sont des algues de culture. Les 5 modalités représentées ont été testées au cours de 30 expériences, réparties en 69, 141, 27, 10 et 29 mesures respectivement pour les conditions 1, 2, 3, 4 et 5, soit un total de 276 mesures.

La matière particulaire totale (MPT, mg l^{-1}), et la charge en matière organique (MOP, mg l^{-1}) définissent la qualité de l'eau de mer. Les charges particulaires sont déterminées par pesées et filtration sur filtres micropores GFC et la matière inorganique (MIP) par la méthode de la "perte au feu" après crémation à 450°C. Les pseudo-fécès sont analysés de façon similaire au seston. La production de pseudo-fécès (i e., organique, minérale ou totale), est exprimée en milligramme par heure. La méthodologie d'analyse des échantillons est décrite en détail par Razet *et al.* (1990).

Tableau 1. Caractérisation des différentes conditions expérimentales. Les 5 modalités alimentaires sont 1. Eau de mer; 2. *Tetraselmis*; 3. *Skeletonema*; 4. *Isochrysis*, 5. *Tetraselmis* et *Thalassiosira*

qualité aliment	expérience	effectif (n)	poids sec (g)	MPT (mg/l)	MOP (mg/l)	MOP (%)
1	1	5	1,11 ± 0,22	7,52	2,70	35,90
	2	5	1,11 ± 0,22	8,22	3,40	41,36
	3	5	1,11 ± 0,22	9,88	4,08	41,30
	4	5	1,03 ± 0,13	8,08	3,24	40,10
	5	6	1,07 ± 0,09	8,86	3,45	38,91
	6	15	0,73 ± 0,17	10,63 ± 0,57	2,68 ± 0,32	25,28
	7	14	0,60 ± 0,14	5,03 ± 0,23	1,67 ± 0,17	33,28
	8	15	0,59 ± 0,14	5,53 ± 1,32	2,11 ± 0,44	38,22
2	9	26	1,25 ± 0,34	3,78 ± 0,65	2,80 ± 0,06	74,01
	10	29	1,03 ± 0,31	4,42 ± 0,18	3,28 ± 0,17	74,63
	11	15	0,67 ± 0,15	4,54 + 0,37	3,12 ± 0,64	68,70
	12	14	1,15 ± 0,39	3,97 ± 0,96	2,61 ± 0,10	65,76
	13	15	0,76 ± 0,11	4,22 ± 0,12	2,75 ± 0,11	65,04
	14	13	0,42 ± 0,15	6,94 ± 1,08	2,78 ± 0,53	40,06
	15	8	0,37 ± 0,16	32,58 ± 2,55	6,52 ± 1,70	20,01
	16	15	0,65 ± 0,11	3,64 ± 0,21	1,92 ± 0,22	52,70
	17	15	0,50 ± 0,08	3,67 ± 0,33	1,98 ± 0,17	54,06
3	18	5	0,97 ± 0,20	8,90	4,10	46,07
	19	4	1,01 ± 0,22	10,19	2,78	27,23
	20	3	1,06 ± 0,27	10,34	4,82	46,62
	21	5	0,95 ± 0,20	7,50	3,00	40,00
	22	5	0,95 ± 0,20	7,92	3,34	42,17
	23	5	0,95 ± 0,20	8,70	3,84	44,14
4	24	10	0,37 ± 0,10	11,87 ± 0,98	8,60 ± 0,43	72,45
5	25	5	1,20 ± 0,15	10,80	4,22	39,07
	26	5	1,20 ± 0,15	12,36	5,34	43,20
	27	5	1,20 ± 0,15	13,36	4,76	35,63
	28	5	1,10 ± 0,13	9,56	4,02	42,05
	29	4	1,07 ± 0,14	9,66	3,72	38,51
	30	5	1,10 ± 0,13	12,86	4,48	34,84

La consommation est calculée par la méthode des biodépots ; La production horaire de matière minérale dans l'ensemble des biodépots estime la consommation minérale (Sornin *et al.*, 1987). La consommation particulaire est obtenue en multipliant la consommation minérale par le rapport MPT/MIP.

Dans un premier temps, la production de pseudo-fécès, en fonction des différentes conditions alimentaires, est comparée à l'aide d'une analyse de covariance. Les différentes covariables retenues sont le poids et la température. La production de pseudo-fécès est ensuite analysée au moyen de régressions linéaires et de régressions multivariables pas à pas.

Dans un deuxième temps, l'étude précise les seuils de production de pseudo-fécès de *Crassostrea gigas* dans les conditions de faibles charges particulaires. Seules les conditions 1 et 2, avec

respectivement 69 et 141 mesures feront l'objet de cette étude. Seul le nombre de mesures dans ces deux conditions expérimentales permet une comparaison statistique appropriée. L'étude se trouve ainsi réduite à une plage de charge sestonique de 3,5 à 11,0 mg l^{-1} propice à l'effet loupe recherché sur les seuils de production de pseudo-fécès.

RÉSULTATS

Production et consommation

La production de pseudo-fécès (Y) peut être considérée comme fonction linéaire de la consommation minérale (X) de l'huître (figure 2).

$$Y = 0{,}718\ X - 0{,}396 \qquad (n = 30) \qquad (1)$$

Cette relation significative explique 76 % de la variance totale du modèle. Dans nos conditions expérimentales, la température n'intervient pas comme un facteur significatif du modèle de production de pseudo-fécès Une consommation minérale de 0,55 mg h^{-1} correspond au seuil minimum induisant une production de pseudo-fécès chez *Crassostrea gigas*.

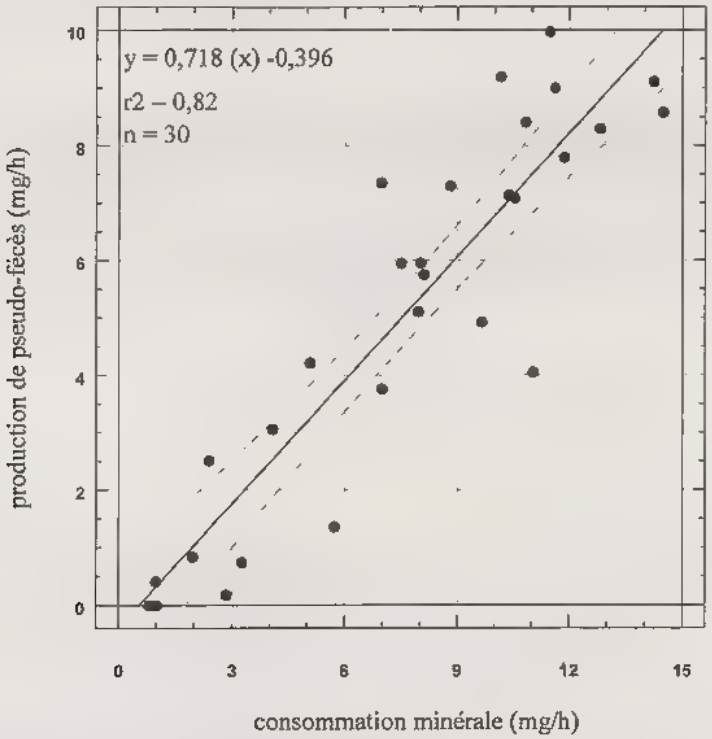

Figure 2· Relation linéaire entre la production de pseudo-fécès et la consommation en matériel particulaire inorganique Les lignes pointillées marquent l'intervalle de confiance des valeurs prédites.

Analyse de covariance sur les conditions alimentaires

La production de pseudo-fécès en fonction des 5 conditions alimentaires est présentée sur la figure 3. La quantité de pseudo-fécès produite est comprise entre 0 et 15 mg h^{-1}. Dans le cadre des mesures effectuées, la production de pseudo-fécès est liée linéairement à la charge sestonique de chaque mesure. L'analyse de l'effet de la qualité alimentaire passe donc nécessairement par une analyse de covariance qui permet d'introduire dans le modèle un carractère régressif concernant la charge particulaire. Ainsi, l'analyse permet de tester si la différence persiste après ajustement de la production de pseudofécès par régression avec la charge particulaire (Snedecor et Cochran, 1957).

L'effet de la qualité alimentaire sur la production de pseudo-fécès est présenté dans le tableau 2. Ainsi pour l'eau de mer additionnée d'*Isochrysis* (modalité 4), et malgré une charge particulaire relativement élevée de 12 mg l^{-1}, la production de pseudo-fécès demeure faible. Les valeurs moyennes de production sont de 5,98; 1,17, 7,17; 1,40 et 4,85 mg h^{-1} respectivement pour les conditions 1, 2, 3, 4 et 5 (figure 4). La covariable, "charge particulaire totale", intervient de façon significative (F = 65,6) dans la dispersion de la variable production de pseudo-fécès. Les quantités de pseudo-fécès produites diffèrent significativement (F = 67,2) en fonction des souches phytoplanctoniques utilisées. Le poids sec de l'huître n'intervient pas de façon significative sur la production de pseudo-fécès s'il est introduit en tant que covariable dans l'analyse. Le test de rang de Newmann et Keuls permet de distinguer 4 groupes sur les 5 conditions alimentaires. Seule la condition eau de mer naturelle avec *Tetraselmis* ne diffère pas significativement de la condition eau de mer avec apport d'*Isochrysis* (tableau 2, modalités 2, 4).

Tableau 2 Analyse de covariance et test de rang sur les 5 conditions alimentaires [VAR] La charge particulaire totale est choisie comme covariable [COVAR] 1 eau de mer, 2 *Tetraselmis*, 3 *Skeletonema*; 4 *Isochrysis* et 5 *Tetraselmis* et *Thalassiosira*.

	carré des écarts	degré de liberté	moyenne au carré	test de Fisher	significativité du test
[COVAR]	394,05	1	394,05	65,6	0,000
[VAR]	1613,59	4	403,40	67,2	0,000
residus	1680,73	280	6,00		
total	4222,69	285			

qualité alimentaire	nombre de modalités	valeurs moyennes Production de pseudo-fécès	test de rang (Newmann et Keuls)
2	150	1,17	*
4	10	1,40	*
5	29	4,85	*
1	70	5,98	*
3	27	7,17	*

Modèles globaux

Les deux conditions alimentaires d'eau de mer naturelle (1) et d'eau de mer naturelle avec un enrichissement en algue *Tetraselmis suecica* (2) sont les seules retenues du fait du nombre de réplicats respectivement de 69 et 141. Les autres modalités testées sur moins de 30 individus, n'ont pas été retenues du fait du faible effectif. Pour chacune de ces conditions, les variables, charge particulaire (X), teneur organique (Y), et poids sec de l'huître, sont considérées dans les modèles explicatifs de la production de pseudo-fécès (Z). Ces modèles sont présentés sur les figures 5 et 6 dans l'intervalle expérimental des conditions de charge particulaire et de teneur en matière organique de l'eau.

Pour la condition sur eau de mer naturelle, le modèle est le suivant, explique 60 % de la variance totale:

$$Z = 1{,}4254\ X + 0{,}1455\ Y - 9{,}9145 \qquad (n = 69) \qquad (2)$$

Pour la condition sur eau de mer et *Tetraselmis*, le modèle explique 61 % de la variance totale:

$$Z = 0{,}6138\ X - 0{,}0344\ Y + 0{,}0773 \qquad (n = 141) \qquad (3)$$

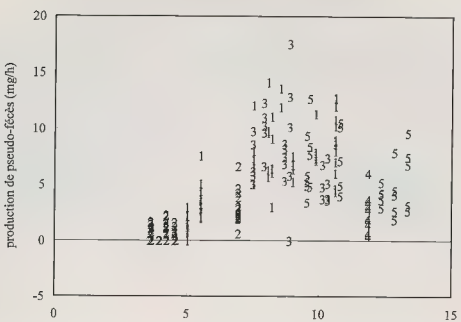

Figure 3· Production de pseudo-fécès de l'huître *Crassostrea gigas* dans des conditions de faibles charges particulaires 1 eau de mer filtrée, 2 *Tetraselmis* sp, 3 *Skeletonema* sp; 4 *Isochrysis*, 5· *Tetraselmis* + *Thalassiosira*.

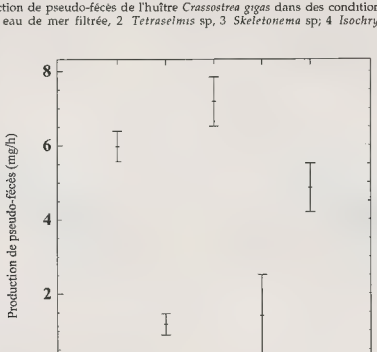

Figure 4: Valeurs moyennes de pseudo-fécès avec intervalle de confiance au seuil de 5% . 1. eau de mer filtrée; 2 *Tetraselmis* sp; 3. *Skeletonema* sp; 4: *Isochrysis*, 5: *Tetraselmis* + *Thalassiosira*.

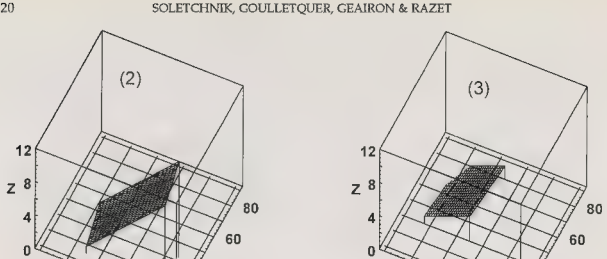

Figure 5. Modèles de production de pseudo-fèces (2)· eau de mer naturelle, (3) eau de mer + *Tetraselmis* X matière particulaire (mg l^{-1}), Y teneur organique de l'eau (%), Z. production de pseudo-fèces (mg h^{-1})

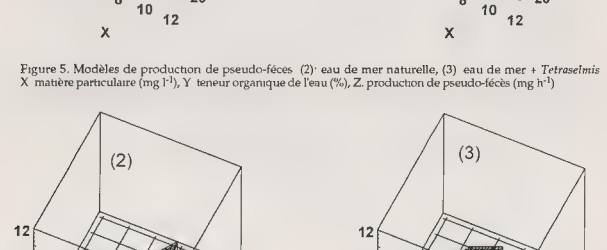

Figure 6: Production de pseudo-fèces (2). eau de mer naturelle; (3)· eau de mer + *Tetraselmis*. Extrapolation des modèles aux valeurs seuil de production de pseudo-fèces X . matière particulaire (mg l^{-1}); Y· teneur organique de l'eau (%); Z: production de pseudo-fèces (mg h^{-1}).

La charge particulaire totale ne dépasse pas 11 mg l^{-1}. Elle est de 5 à 11 mg l^{-1} pour la condition sur "eau de mer naturelle" (modèle 2) et de 3,55 à 7 mg l^{-1} pour la condition algue (modèle 3). La teneur organique est comprise entre 25 et 41 % pour la condition eau de mer, et 40 à 81 % pour la condition alimentaire avec apport de *Tetraselmis*.

En condition d'eau de mer naturelle, l'huître se situe toujours au-dessus du seuil de production de pseudo-fécès (figure 5 (2)). Pour la condition alimentaire avec apport de *Tetraselmis*, le seuil de production est atteint pour les forts taux organiques (65 - 80 %) (figure 5(3)). L'extrapolation de ces deux modèles (2) et (3) permet de définir des seuils de production de pseudo-fécès entre 4,4 et 2,9 mg l^{-1} (modèle 2) et entre 2.12 et 4.37 mg l^{-1} (modèle 3) (tableau 3). Ces deux modèles sont complémentaires dans la gamme des teneurs organiques décrites. Elles varient entre 25 et 40 %, et 40 et 80 % pour les modèles 2 et 3 respectivemnent.

Tableau 3 Seuil de production de pseudo-fécès pour les deux modèles expérimentaux, (1). modèle sur eau de mer, (2). modèle sur algue *Tetraselmis sp.*

Teneur organique (%)	eau de mer (1)	*Tetraselmis* (2)
25	4,40	
30	3,89	
35	3,38	
40	2,87	2,12
50		2,68
60		3,24
70		3,81
80		4,37

DISCUSSION

La quantification de la production de pseudo-fécès chez les bivalves, est un sujet largement abordé (Tenore et Dustan, 1973; Foster-Smith, 1975; Tsuchiya, 1980; Haven et Morales, 1966) et en particulier par Bernard (1974), Sornin (1981), Razet *et al.* (1990) et Barillé *et al.* (1994) pour *Crassostrea gigas.*

Au-delà de l'aspect quantitatif, différents niveaux d'investigation de la matière alimentaire peuvent être envisagés: sur des critères biométriques, dont l'origine remonte à Atkins (1937) et dont les mécanismes de tri sont décrits en détail par Barillé *et al.* (1994); sur des critères de densité (Bernard, 1974); d'espèces phytoplanctoniques (Loosanoff, 1949; Menzel, 1955; Kiorboe et Mohlenberg, 1981; Newell et Jordan, 1983; Bricelj et Malouf, 1984, Iglésias *et al.*, 1992; Navarro *et al.*, 1992); ou sur des critères organiques ou de nature biochimique (Razet *et al.*, 1990; Bayne *et al.*, 1993).

Si les mécanismes de tri chez les bivalves et chez *Crassostrea gigas* en particulier (Barillé *et al.*, 1994) commencent à être connus, nous avons actuellement peu de connaissances sur ceux contrôlant le déclenchement de l'émission des pseudo-fécès.

Les faibles charges particulaires, inférieures à 11 mg l^{-1}, utilisées dans ces différentes expérimentations, ne permettent pas de comparaison directe avec les études réalisées jusqu'alors chez *Crassostrea gigas* (Bernard; 1974, Deslous Paoli *et al*; 1992, Razet *et al.*, 1990). Les résultats expérimentaux obtenus "in vitro" à partir d'une eau de mer naturelle (modalité 1) correspondent en fait à des gammes de charges particulaires en suspension observées uniquement en marées de mortes eaux, et à une fréquence assez faible (Héral *et al.*, 1980, Soletchnik *et al.*, 1991). La deuxième condition testée (i.e., alimentation avec apport de *Tetraselmis*), est une condition plus exceptionnelle concernant les teneurs en matière organique qui ne dépassent pas 30% dans des conditions naturelles de blooms phytoplanctoniques (Héral *et al.*, 1980). Ainsi le deuxième modèle permet d'étendre le modèle de production de pseudo-fécès aux conditions de culture propres aux écloseries et à certaines conditions de cultures en marais où l'alimentation est beaucoup plus riche en matière organique.

La production de pseudo-fécès peut être exprimée en fonction de la consommation préférentiellement à la charge particulaire (Barillé *et al.*, 1994, Raillard *et al.*, 1992). Ce dernier auteur fait apparaître le seuil de production de pseudo-fécès à 10 mg h^{-1} de consommation de matière particulaire. Cette valeur est en fait de 0,55 mg h^{-1} de matière inorganique consommé, équivalent à 1 mg h^{-1} de matière particulaire totale consommé dans le cadre de cette étude ciblée sur les charges particulaires autour du seuil de production de pseudo-fécès.

Une relation est souvent mise en évidence entre le seuil de production de pseudo-fécès et la taille des particules (Loosanoff et Engle, 1947; Winter, 1969, 1978), qu'il s'agisse de particules minérales ou d'algues (Foster-Smith, 1975). Chez *Crassostrea gigas*, le seuil est situé à 2,1 mg l^{-1} avec une variété de navicules *Haslea ostrearia* de taille moyenne de 98 µm, et à 2,33 mg l^{-1} avec une variété à 65 µm.

Tableau 4 Charge particulaire minimale induisant la production de pseudo-fécès chez quelques bivalves marins.

Mytilus edulis	matière particulaire	4,5-5,0	Widdows *et al.*,1979
Mytilus edulis	matière particulaire + phytoplancton	2,6-3,0	Bayne *et al.*, 1993
Cerastoderma edule	matière particulaire	1,5	Navarro *et al.*, 1992
Crassostrea virginica	matière particulaire	3,0-5,0	Haven et Morales-Alamo, 1966
Crassostrea gigas	matière particulaire	4,6	Deslous-Paoli *et al.*, 1992
Crassostrea gigas	Navicule (*Haslea ostrearia*)	2,1-2,3	Barillé *et al.*, 1994
Crassostrea gigas	matière particulaire	2,5-4,3	cette étude
Crassostrea gigas	matière particulaire + *Tetraselmis* sp.	2,2-4,0	cette étude

Le tableau 4 présente les principaux résultats de seuil de production de pseudo-fécès pour plusieurs espèces de mollusques bivalves en fonction de la charge sestonique. Le seuil est compris entre 2,1 et 5,0 mg l^{-1} pour les trois espèces présentées et entre 2,6 et 5,0 pour *Mytilus edulis* (Widdows *et al.*, 1979; Bayne *et al.*, 1993), entre 3,0 et 5,0 pour *Crassostrea virginica* (Haven et Morales-Alamo, 1966) et entre 2,1 e 4,6 mg l^{-1} pour *Crassostrea gigas* (Barillé, 1994; cette étude).

Le poids de l'huître, pris en compte lors de la recherche d'un modèle de production de pseudo-fécès, n'apparaît pas comme une variable explicative dans le cadre de cette étude. Chez d'autres espèces telle que la moule, *Mytilus edulis*, l'influence du poids sur la production de pseudo-fécès a été démontrée (Bayne et Worrall, 1980, Widdows *et al.*, 1979) Sur l'huître *Crassostrea gigas*, Arakawa (1970) montre également l'influence de la taille des huîtres sur la production de pseudo-fécès à la différence de la présente étude. La raison principale évoquée est l'intervalle des très faibles charges particulaires comprises entre 3,5 et 11,0 mg l^{-1}.

Concernant l'influence des facteurs abiotiques, la température est certainement le facteur qui semble le plus à même d'influencer la production de pseudo-fécès. Cet effet est mis en évidence au cours d'études "in situ" par Haven et Morales (1966) et Loosanoff (1958). Ces auteurs trouvent que les très basses températures (2-5°C) peuvent aller jusqu'à inhiber toute production de biodépôts chez *Crassostrea virginica*. Ces résultats sont confirmés par des études "in vitro" (Walne, 1972; Tsuchiya, 1980). Sornin (1981) obtient une relation inverse de celle obtenue par Kuzuki (1978), et considère l'effet direct de la température sur la production de biodépôts.

Dans le cadre de cette étude, la méthodologie mise en oeuvre (Widdows *et al.*, 1975) est associée à l'idée que les huîtres sont naturellement acclimatées à la condition de température saisonnière (13-20 °C) (Bayne *et al.*, 1993). Dans ces conditions de mesure et dans la gamme de température de 13-20°C, la fonction de production de pseudo-fécès est indépendante de la température saisonnière.

CONCLUSION

Les deux modèles de production de pseudo-fécès obtenus au cours de cette étude correspondent à deux gammes de teneurs organiques bien distinctes et permettent d'affiner le seuil de production de pseudofécès dans des conditions environnementales également bien distinctes. La première gamme, entre 25 et 40 % de matière organique, représente les teneurs naturelles de matière organique dans le milieu (Héral *et al.*, 1980). Les seuils de production obtenus par Deslous-Paoli *et al.* (1992) et Barillé *et al.* (1994), avec respectivement 16% et 54% de matière organique dans l'eau, sont en accord avec les résultats de ce premier modèle. Le deuxième modèle construit avec une eau dont la teneur organique est comprise entre 40 et 85 %, correspond à une gamme de charges sestoniques et de teneur organique des conditions d'élevage en écloserie ou en semi-intensif dans des structures telles que les claires ostréicoles. Par conséquent, les résultats doivent contribuer à l'évolution des modèles biologiques de l'huître *Crassostrea gigas*, ainsi qu'à leur application dans la gestion des élevages dans différents écosystèmes contrôlés.

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An Australian planorbid freshwater snail recently introduced to the island of Martinique: *Amerianna carinata* (H. Adams, 1861)

Jean-Pierre POINTIER [1]

RÉSUMÉ

Un planorbidé australien, mollusque d'eau douce récemment introduit dans l'île de la Martinique: *Amerianna carinata* (H. Adams, 1861)

L'introduction du mollusque planorbidé australien *Amerianna carinata* a été signalée en 1987 dans la rivière du Galion, Martinique La présence de cette espèce avait été signalée en Indonésie (Java) en 1951, en Thaïlande en 1974 et en Afrique (Nigeria) en 1983 Une description détaillée de sa morphologie est donnée pour la première fois. Les caractères anatomiques sont en bon accord avec ceux déjà décrits pour plusieurs espèces du genre *Amerianna* par Hubendick (1951)

ABSTRACT

The introduction of the Australian planorbid snail *Amerianna carinata* was reported in 1987 in Galion River, Martinique. The presence of this species was already reported from Indonesia (Java) in 1951, from Thailand in 1974 and from Africa (Nigeria) in 1983. A detailed description of its morphology is given for the first time Anatomical characteristics are in accordance with those already described for several species belonging to the genus *Amerianna* by Hubendick (1951).

INTRODUCTION

In April 1987, a planorbid snail was collected in a small protected area along banks of the Galion River, Bassignac, Martinique. Similar samples were collected in the same site in 1994 and identified as *Amerianna carinata,* an Australian Planorbid snail. This species was first described by H. Adams in 1861 from the Boyne River, Australia, as followed: "*P. testa subovata, tenui, pallida flavo-fusca; spira brevissima, apice planato; anfractibus 3, postice planatis et valde carinatis; apertura subovali, plica columellari mediocri*". It was also reported in 1951 in Java by Butot (1954) who collected several specimens in aquaria and ponds of the Bogor Botanic Gardens. Drawings of the shell and details of the mandibula and radula were given in Butot's paper. In his critical revision of the Javanese freshwater gastropods Van Benthem-Jutting (1956) confirmed the immigration of this species in Java. It was also reported from Thailand by Brandt (1974). More recently Jelnes and Fagbemi (1983) and Brown (1983) reported the introduction of *A. carinata* to the Lake Ibadan, Nigeria and a brief description of the copulatory organ was given by the last author. In our paper, macro-anatomy of the digestive, respiratory and reproductive systems of the specimens collected in the Galion River, Martinique are described.

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MATERIAL AND METHODS

Present study looks to 35 specimens collected in April 1987 and 32 snails collected in June 1994 in the Galion River, Bassignac (14°44'N, 60°59'W). Snails to be dissected were allowed to relax overnight using menthol. Then they were immersed for 40s in hot water (70°C), from which they were transferred to water at room temperature. The soft parts (under water) were drawn from the shells with a small forceps applied to the cepahopedal mass, and fixed in slightly modified Railliet Henry's fluid (distilled water 930ml, sodium chloride 6g, formalin 40% 50ml, glacial acetic acid 20ml). All dissections were done under a stereoscopic microscope and drawings were made using a camera lucida attachment. Voucher specimens (shells and preserved soft parts) were deposited in the Museum National d'Histoire Naturelle de Paris.

RESULTS

Shells of *A. carinata* collected in 1987 and 1994 in the Martinique island have a maximum high of 8.3mm and 9.4mm respectively They are similar to the illustrated specimens from Java (Butot, 1954; Van Benthem-Jutting, 1956) and Nigeria (Brown, 1983) and are of the same order of magnitude than the type series in the British Museum (10.5-11.8 mm). The carinate shoulder is typical of this species and is more or less pronouced (Fig. 1). The shells of small and medium size present spiral ridges distributed over all the surface and the apex has no punctuations according to Brown (1983).

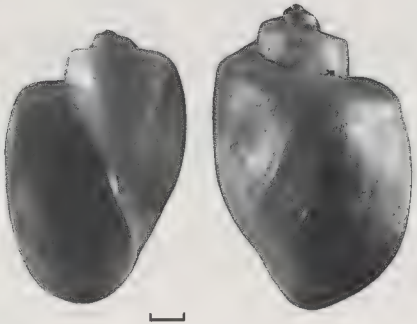
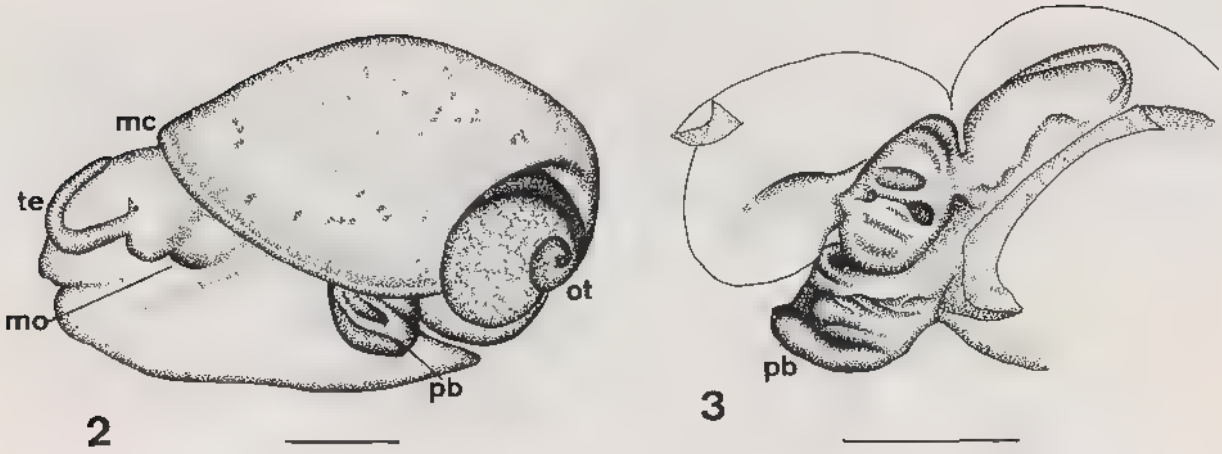


Figure 1. Shells of *Amerianna carinata* from Galion River, Martinique. Bar = 1 mm

The mantle is pigmented with very few and small melanic patches mainly concentrated near the collar (Fig. 2). The pseudobranch is well developped, deeply folded and widely jut out the mantle collar (Fig. 2-3). Salivary glands attached to the buccal mass are massive and beset with well-developed diverticula, their shape vary from knob-like to finger-like (Fig. 4). The oesophagus is stout and short and expands into the anterior part of the stomach also called the cardiac part. The intestine leaves the posterior part (piloric part) of the stomach and curves around it forming a lower loop, then swings above the cardiac part forming a larger upper loop. This morphology is usually observed in the freshwater pulmonates (Malek, 1985) The renal tube is short and shows no renal ridge. It is pushed inward to form well marked lamellae ot kidney folds . The ureter is reflected and is approximatively four time shorter than the renal tube (Fig. 5).



Figures 2-3 *Amerianna carinata* 2 Body, left side mc = mantle collar, mo = male opening, ot = ovotestis, pb = pseudobranch, Te = tentacle Bar = 1 mm 3 Detail of pseudobranch (pb). Bar = 1 mm.

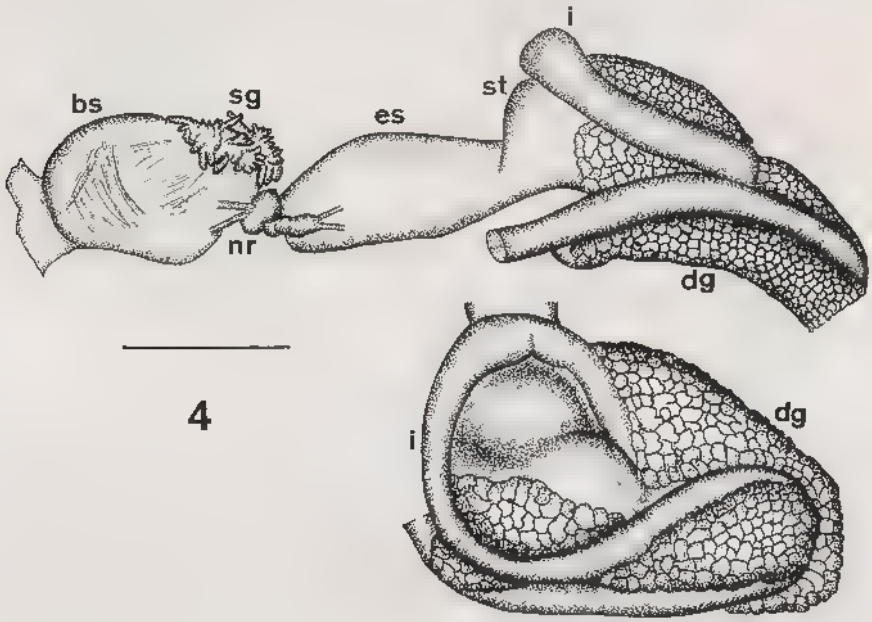


Figure 4 *Amerianna carinata* Digestive system bs = buccal sac, dg = digestive gland, es = esophagus, i = intestine, nr = nervous ring, sg = sslivary gland, st = stomach Bar = 1 mm

The reproductive system shows following characters The ovotestis has 90 to 110 rounded diverticula, and most are unbranched (Fig. 6) The collecting canal of ovotestis is longer and much wider than the proximal and distal segments of the ovispermiduct. The seminal vesicle is highly convolute without diverticula. The oviduct has a massive complex shape roughly quadrangular and is more or less covered with protuberances which vary in shape and size. The albumen gland is very bulky and bean-shaped. The anterior part of the oviduct pouch is beset with several rows of well-developed protuberances having cord-like appearance (Fig. 7). The vagina is very short without pouch. The spermatheca is massive and club-shaped with a body longer than the duct. In its normal position, the spermatheca covers almost entirely the prostate. This latter is compact, composed of

20 to 30 diverticula and the most of them are bifurcate or trifurcate and tightly packed giving to the organ a cauliflower-like appearance (Fig. 7). The spermiduct is wide and slightly flat with its boundaries lined by rounded protuberances. The penial complex shows no flagella or other accessory organs. The penis is circular in cross-section in its anterior part with a triangular tendency in its posterior part. It has no stylet and its tip has a terminal opening. The penial sheath is commonly invaginated to a less or greater extent into the prepuce. The penial complex shows a set of retractor muscles.

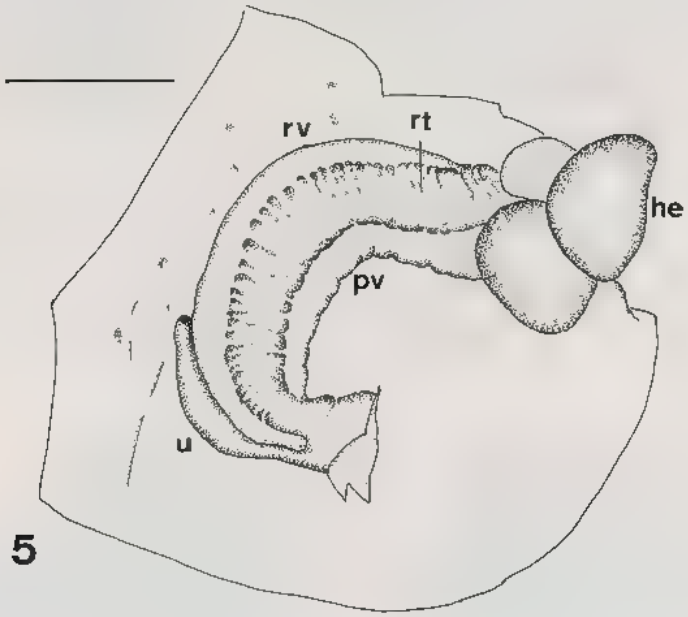


Figure 5 *Amerianna carinata* Pallial organ he = heart, pv = pulmonary vein, rv = renal vein, u = ureter, rt = renal tube Bar = 1 mm

DISCUSSION

Anatomical characteristics of *A. carinata* are in accordance with those already described in the genus *Amerianna* by Hubendick (1955) but some points deserve particular mention. The ureter of *A. carinata* is reflected as in *A. buruanus* from Rana Lake, Buru island and *A. pesigani* from Tibo River, Mindoro, Philippines. However, in *A leopoldi* from Angi-Gita Lake, New Guinea and *A obesa* from Somerset Dam, Queensland, it is S-shaped. In *A. carinata* there is no renal ridge, but a short ridge occurs in *A. buruanus*. The form of the penis may also vary according to different species. In *A. carinata*, it is circular in cross-section in its anterior part and becoming triangular in its posterior part. In *A. pesigani* it is circular, in *buruanus* irregularly rectangular, in *leopoldi* triangular and in *obesa* it looks like *carinata*. Recently Walker (1988) reports that the opening of the vas deferens of specimens from Australia is terminal or lateral. The two forms are found in snails with similar shell morphology and the author writes that it is not yet possible to conclude with certainty the position of the type species. Specimens collected from Martinique have a terminal pore as described in Nigerian specimens (Brown, 1983).

The recent discovery of an Australian planorbid snail in a river from the Martinique island seems unforeseen but during the last decades several species of freshwater snails were introduced into this island. These introductions may have several origins. As it was pointed out by Malone (1965), some freshwater snails could be dispersed through the intestinal tract of water birds Mammals also could play a role since snails or egg masses may lodge in the mud on animal'body (Madsen and Frandsen, 1989). However, in Martinique, the more important mean of introduction is linked to the aquatic plant trade which considerably increased during the last twenty years

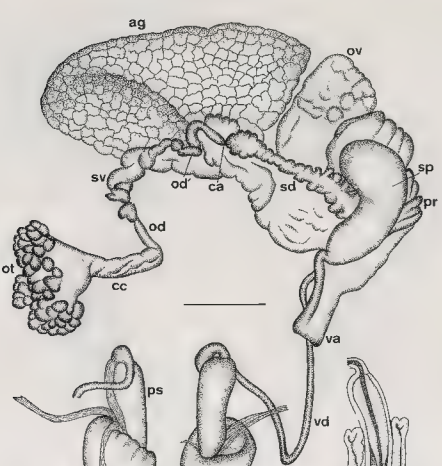


Figure 6. *Amerianna carinata* Genital organs ag = albumen gland, ca = carrefour, cc = collecting canal of ovotestis, od = proximal segment of ovispermiduct, od' = distal segment of ovispermiduct, ot = ovotestis, ov = oviduct, pp = preputium, pr = prostate, ps = penis sheath, sd = spermiduct, sp = spermatheca, sv = seminal vesicle, va = vagina, vd = vas deferens.

following the inflationary demand for ornamental aquaria. A review of this problem is presented by Madsen and Frandsen (1989) who gave details of the introduction and spreading of eight species of Pulmonate and Prosobranchs.

In Martinique, the first noteworthy introduction may have occurred in the sixthies when Grétillat (1967) pointed out for the first time the presence of a small planorbid snail *Biomphalaria straminea*, a potential intermediate snail host for intestinal schistosomiasis (under the name of *B. havanensis*). An extensive survey carried out between 1972 and 1978 showed that this species had colonized numerous waterbodies displacing some populations of another planorbid snail, *B. glabrata* (Guyard and Pointier, 1979). More recently in 1985, *B. straminea* was found in ponds in Grande Terre of Guadeloupe, a neigthbouring island (Pointier *et al.*, 1993).

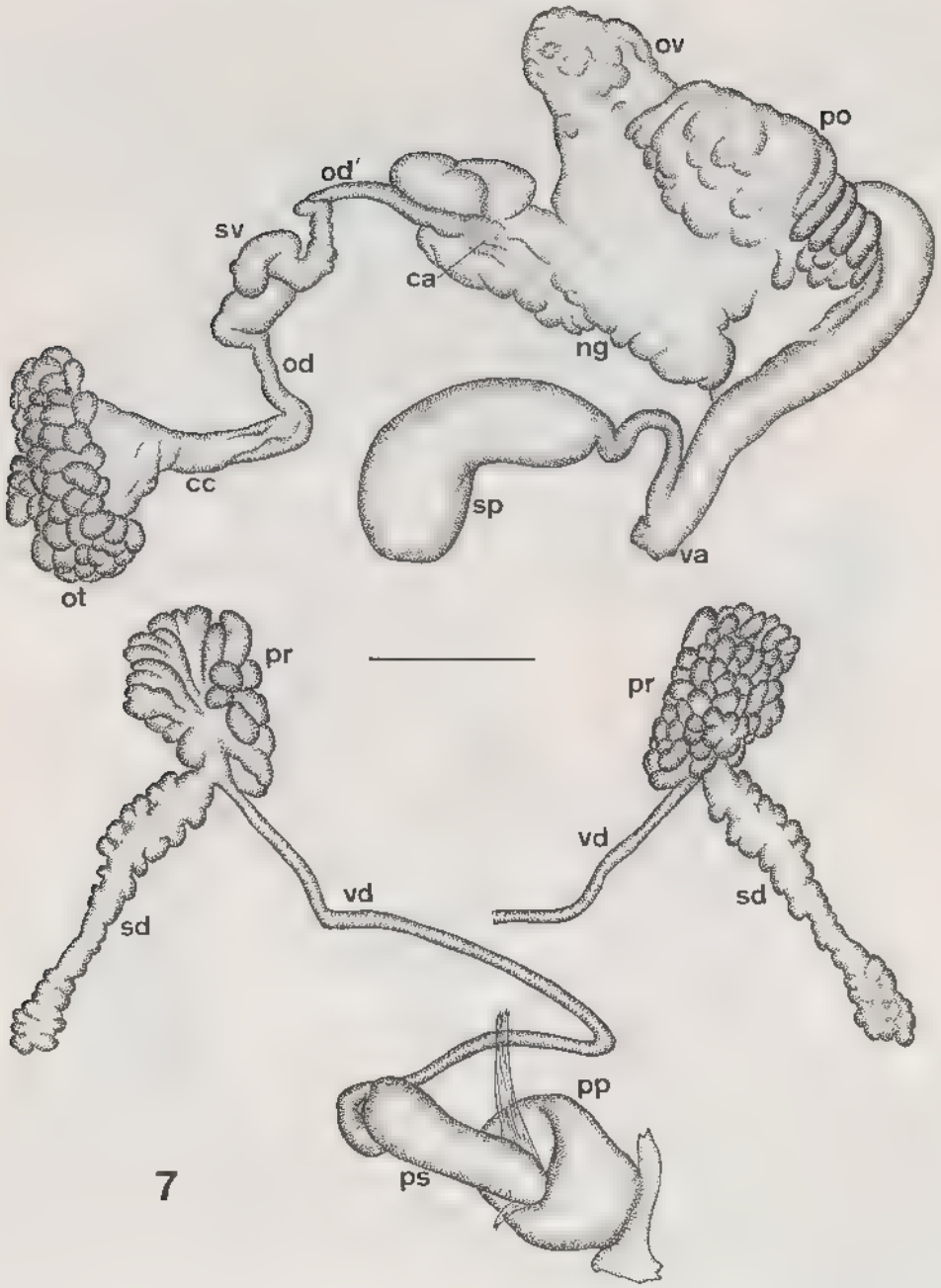


Figure 7. *Amerianna carinata*. Genital organs. Male part was removed and presented below the female organs. ag = albumen gland, ca = carrefour, cc = collecting canal of ovotestis, od = proximal segment of ovispermiduct, od' = distal segment of ovispermiduct, ot = ovotestis, ov = oviduct, pp = preputium, pr = prostate, ps = penis sheath, sd = spermiduct, sp = spermatheca, sv = seminal vesicle, va = vagina, vd = vas deferens.

Another important freshwater snail was recently introduced into Martinique, *Melanoides tuberculata*. This thiarid snail which is originating from Middle East and East Africa appeared for the first time in 1979 in Madame River, Fort-de-France (Pointier and McCullough, 1989). Several morphs of this species were then recognised in the island suggesting that several distinct introductions occurred during subsequent years (Pointier, 1989). *M. tuberculata* have habilities of rapid dispersal and in 1990 the whole hydrographic system was colonized (Pointier *et al.*, 1993).

Consequences of such invasion could be seen as positive from a human perspective because it has strongly reduced populations of *B. glabrata* and *B straminea*, the intermediate hosts of schistosmiasis, in several transmission sites such as water-cress beds, ponds, canals and small streams (Pointier *et al*, 1989; Pointier and Guyard, 1992). Consequences for other indigenous freshwater snails remain unknown. However, until now there is no evidence that local snails, which include four Caribbean species (*Pomacea glauca, Neritina virginea, N punctulata* and *Neritilia succinea*) are threatened with extinction.

The introduction of *A carinata* shows a completely different result. This species was initially recorded in Galion River in April 1987 and the presence of the snail was confirmed at this site during the following years. Twice a year malacological surveys are carried out all over the island and *A. carinata* was never discovered in other habitats. Thus the species seems really restricted to a single site which indicates that probabilities of spreading to other waterbodies are very low. The presence of dense populations of the thiarid snails in the whole hydrographic system could prevent the establishment of new colonies of this unusual snail.

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Marine Bivalves from off the Southern Iberian Peninsula collected by the Balgim and Fauna 1 expeditions

Carmen SALAS [1]

RÉSUMÉ

Bivalves marins du Sud de la Péninsule Ibérique récoltés par les campagnes Balgim et Fauna 1

Une liste est établie pour les Bivalves (239 espèces) récoltés par la campagne française "Balgim" (1984) et la campagne espagnole "Fauna 1" (1989) dans la mer d'Alboran, le détroit de Gibraltar et le golfe Ibéro-Marocain, avec le détail du matériel examiné. Les Nuculidae, Nuculanidae autres Protobranches, Limopsidae et Cuspidariidae sont particulièrement bien représentés, et sont traités en détail avec des illustrations de la plupart des espèces.

Changements nomenclaturaux ou taxonomiques: *Bathyarca pectunculoides* (Scacchi, 1834) est rétablie comme nom valide (requête à la CINZ en cours); *Limopsis angusta* (Jeffreys, 1879) est reconnue comme espèce valide, distincte de *L. minuta* (Philippi, 1836), *Limaria tuberculata* (Olivi, 1792) est reconnu comme le nom valide de "*Limaria inflata* (Chemnitz)"; *Thyasira perplicata* n. nov. est proposé comme nom de remplacement pour *Cryptodon plicatus* Verrill, 1885 non Adams, 1862, *Neolepton obliquatum* Chaster, 1897 est transféré dans *Mysella* (Montacutidae), *Cuspidaria striolata* Locard, 1898 est placée en synonymie de *C. costellata* (Deshayes, 1835).

Il y a clairement une influence de l'écoulement d'eau méditerranéenne sur la distribution des Bivalves. c'est une barrière que ne pénètre pas la faune profonde Nord-Atlantique. Le cortège d'espèces exclues de l'écoulement méditerranéen est trouvé sur la pente marocaine à partir de 700 m de profondeur, et dans l'axe du détroit à des profondeurs comparables en dessous de la veine d'eau méditerranéenne, mais reste confiné en dessous de 1300 m environ au large de Huelva. Au niveau du Cap St. Vincent, l'influence de l'eau méditerranéenne est très atténuée et n'affecte pratiquement pas la distribution des Bivalves.

ABSTRACT

The Bivalves (239 species) obtained during the French cruise "Balgim" (1984) and the Spanish cruise "Fauna 1" (1989) in the Alboran Sea, Strait of Gibraltar and Ibero-Moroccan Gulf, are listed with detail of material examined. The Nuculidae, Nuculanidae and other Protobranchs, Limopsidae and Cuspidariidae are well represented and are given particular attention, with most of the species illustrated.

Taxonomic or nomenclatural decisions herein: *Bathyarca pectunculoides* (Scacchi, 1834) restored as valid name (ICZN application pending), *L. angusta* (Jeffreys, 1879) recognized as valid and distinct from *L. minuta* (Philippi, 1836), *Limaria tuberculata* (Olivi, 1792) used as the valid name for "*Limaria inflata* (Chemnitz)"; *Thyasira perplicata* new name for *Cryptodon plicatus* Verrill, 1885 non Adams, 1862, *Neolepton obliquatum* Chaster, 1897 transferred to *Mysella* (Montacutidae); *Cuspidaria striolata* Locard, 1898 synonymized with *C. costellata* (Deshayes, 1835).

There is a definite influence of the Mediterranean outflow on the distribution of Bivalves: it is a barrier which keeps out the deep water Atlantic fauna. The suite of species affected is found along the Moroccan slope as shallow as 700 m, and in the axis of the Strait at similar depths below the Mediterranean water, but is restricted to depths below ca. 1300 m off Huelva. Off Cape St. Vincent, the incidence of the Mediterranean outflow is very attenuated, and practically does not affect the bathymetric distribution of the Bivalves.

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INTRODUCTION

The Southern part of the Iberian Peninsula is a key area for North Atlantic marine biogeography, being at the confluence of three major regions (Ekman, 1953): Lusitanian, Mauritanian and Mediterranean. The overlapping ranges of many species results in an increased species richness, possibly the highest of European seas.

The Strait of Gibraltar is of a major importance for the hydrology of adjacent areas and has been intensively studied by physical oceanographers (Gascard & Richez, 1985; see also Minas, Coste and Minas, 1984 for a very readable divulgative account). The inflow of Atlantic water is superficial (the upper 200 m) and spreads clockwise into the Alboran Sea; a vein of more dense Mediterranean water flows out of the sill westwards, and comes off the bottom to stabilize at a depth of ca. 1200-1300 m along the Southern Iberian slope. The incidence of hydrological factors on the sedimentation (Kelling & Stanley, 1972) and on the fauna have been extensively studied.

A particular feature of interest in the Straits of Gibraltar is the occurrence of endemic species in the littoral fauna, on which attention has been called in recent papers (Verduin, 1984; Cervera *et al.*, 1988; Gofas, 1988; Salas, 1994).

The Molluscan fauna of the Southern Iberian peninsula, more particularly on the Atlantic side, has been sampled in the past by several expeditions with a broader scope: "*Lightning*" and "*Porcupine*" (Jeffreys 1878, 1879, 1881, 1882, 1883a, 1883b, 1884a, 1884b, 1885), "*Challenger*" (Smith, 1885), "*Travailleur*" and "*Talisman*" (Locard, 1898). Most relevant samples from those cruises are dredge hauls on the slope of the Ibero-Moroccan gulf.

More recently, in 1958, the R/V "*Calypso*" sampled the benthic shelf communities of the Alboran Sea and the Ibero-Moroccan gulf, and a general report was published by Peres (1962); there was no particular report on the Mollusca, most of which are now in MNHN. Another French cruise, "*Polymede II*", sampled 15 sites between 84 and 1116 m in the Alboran Sea (Sibuet, 1974).

There is much published work on the littoral fauna of the Southern Iberian Peninsula, either devoted to particular taxonomic groups or to the fauna of particular sites. An extensive list of references can be found in Templado *et al.* (1993).

This paper is devoted to the Bivalves collected by the French expedition Balgim and the Spanish expedition Fauna 1 in the area.

1) Balgim expedition in May-June 1984 was leaded by Philippe Bouchet, of Muséum National d'Histoire Naturelle, Paris (MNHN), and carried out on board R/V "Cryos" of IFREMER, with funding by Centre National de la Recherche Scientifique (PIROCEAN). Its main objective was to study the relationship between water masses and benthic fauna at the Mediterranean-Atlantic transition. The material was sorted at the Centre National de Tri d'Oceanographie Biologique (CENTOB), Brest, and reports have appeared over the past decade for several groups (Ascidians: Monniot & Monniot, 1988, Gorgonians: Grasshoff, 1989; Echinids: David, 1989; Hydroids: Ramil & Vervoort, 1992; Bryozoans Harmelin & d'Hondt, 1992; Sponges: Boury-Esnault, Pansini & Uriz, 1994; Barnacles: Foster & Buckeridge, 1995).

2) Fauna 1 cruise in July 1989 was part of the "Fauna Ibérica 1" (DGICYT PB87-0397) project and was leaded by Dr. A. Guerra (Instituto de Investigaciones Marinas (CSIC), Vigo) on board R/V "García del Cid". This cruise was dedicated to sampling the fauna of the shelf (mostly 30 to 300 m) of the Southern Iberian peninsula, leaving aside the shallow parts accessible by SCUBA diving and the slope already sampled by Balgim. The material was sorted and stored in Museo Nacional de Ciencial Naturales, Madrid (MNCN). Fauna 1 cruise was particularly targeted to obtaining material for the collections in MNCN, and producing appropriate data for monographs of the marine fauna of the Iberian peninsula. A preliminary report, with many colour photographs of living animals, was issued by Templado *et al.* (1993).

This report on the Bivalves from both cruises features a list of 239 species, with detail of material examined of each one. Part of the material from Balgim had been previously examined by other researchers. The protobranchs were examined and identified by Anders Warén (Naturhistoriska Riksmuseet, Stockholm) for further reference on the taxonomy of the group. Henk Dijkstra (Nationaal Natuurhistorisch Museum, Leiden) had examined and identified a large part of the Pectinidae.

For some species, remarks on the taxonomy or on some particular characters are given. The Protobranchs, Limopsidae and Septibranchs are particularly well represented and have been given particular attention: most of the species in these groups are illustrated and some taxonomic decisions have been taken using this material. The taxonomic treatment of the family Thyasiridae, also important in the deep water samples, is more tentative: a thorough revision is needed before the South European species can be accurately named, and the material examined here was not considered sufficient for this purpose.

A possibly dismaying observation is the low amount of undescribed species in both cruises, despite the importance of the sampling effort and the lack of relevant cruises earlier in this century. Fauna 1 collected *Notolimea clandestina* Salas, 1994, presumably endemic of the Strait of Gibraltar, near Cape Trafalgar and a small undescribed Nuculidae (which will be described separately) from Alboran Island; Balgim collected valves of a large Vesicomyidae and of a Solemyidae which are currently under study and will be described elsewhere, and possibly undescribed *Dacrydium* (Mytilidae).

Finally, a biogeographical analysis has been attempted, with the purpose to detect possible affinities between stations and between species, and to relate the species with environmental factors such as bathymetry, water masses, and latitude. The data were used to construct a presence/absence matrix including every species collected alive in more than one station. A correspondence analysis was performed for species and for stations.

SYSTEMATIC PART

The arrangement of the families follows the Treatise on Invertebrate Paleontology (Moore ed., 1969) except for the Protobranchia which are arranged following Allen & Hannah (1986), or alternative views by Maxwell (1988). The overall observed depth range for specimens, shells and valves is indicated for each species, at the beginning of the listing of material examined.

Abbreviations used: "spec(s)." refers to live-taken specimens, "sh." to bivalved shells, "v." to single valves, "jv." to juveniles. The numbers in brackets for Fauna 1 lots refer to accession numbers in MNCN.

SOLEMYIDAE

Solemya togata (Poli, 1791)
Tellina togata Poli, 1791, Test. Sicil. I. 42, pl. 15 fig. 20

Material (12-16 m). Fauna 1 60A: 4 specs. (jv.)

Acharax sp.

Material (1250 m): Balgim CP62: 1 sh.

NUCULIDAE

Nucula sulcata Bronn, 1831 (figs. 1-3)
Nucula sulcata Bronn, 1831 - Ergeb. nat. Reisen II: 617

Material (56-398 m): Balgim DR23: 4 v. - DW24: 2 sh. + 12 v. - CP25: 2 sh. + 23 v. - DW27: 2 specs. + 2 v. - DW28: 2 specs. + 1 v. - DW32: 4 specs. - CP33: 9 specs. + 3 v. - CP34: 43 specs. + 11 v. - DW47: 5 v. - DR51: 1 v. - DR70: 1 spec. + 7 v. - DR71: 1 spec. (jv.) + 2 v. - DR72: 1 v. - DR73: 1 v. - DW74: 2 v. - DR101. 1 spec. + 4 v. - DR118. 1 spec. + 3 sh. + 17 v. - CP119: 1 spec + 1 v. - DW120: 48 specs. (43 jv.) + 2 sh + 35 v. - DW121. 1 v. - DW128: 3 specs + 17 v.

- CP135: 12 specs. (8 jv)+1 sh.+29 v - DW136 1 v. - DR144 1v - CP145 3 v - DW146 2 specs (jv.)+1 sh + 11 v - DW147· 3 specs. (2 jv.) - CP148: 2 v. - CP149: 3 specs +3 v. - CP150: 3 v

Fauna 1 1A· 4 specs (1042) - 3A: 1 spec (1034) - 5A 1 spec (1018)+1 spec (1021) - 14A. 10 specs. (1076) - 48A· 1 spec (1204) - 49A 1 spec (1207) - 50A. 1 spec (1098) - 67A 1 spec (1024) - 67A 1 v (1044) - 69A. 5 specs. (1217) - 69A: 1 spec. - 73A. 1 v. (1213) - 73A. 1 v. - 76A: 2 v.

Remarks: This is the most common nuculid, and one of the most common bivalve species, on muddy flats of the outer shelf in the Ibero-Moroccan area. I have illustrated a juvenile specimen to show the smooth early part of the teleoconch and the sudden onset of the characteristic wrinkles.

Nucula tumidula Malm, 1860 (figs. 4-6)
Nucula tumidula Malm, 1860 - Forh. Skand. Naturf.: 621

Material (1255-1527 m) Balgim DW11 3 specs +2 v - CP91 1 v - CP92 1 v - DW96: 2 specs.+2 v - CP99 1 sh. - CP108: 2 specs.

Nucula atacellana Schenck, 1939 (figs. 7-9)
Nucula (Nucula) atacellana Schenck, 1939 J Paleontol. 13 (1) 27, pl 5 figs 4, 5, 9, 10, 13, 16 replacement name for *Nucula reticulata* Jeffreys, 1876 (non Hinds, 1843) = *Nucula cancellata* Jeffreys, 1881 (non Meek & Hayden, 1856)

Material (1378 m). Balgim CP95. 1 spec.

Nucula nucleus (Linné, 1758) (figs. 23-24)
Arca nucleus Linné, 1758 - Syst. Nat , ed. 10· 695

Material (60-62 m)· Fauna 1 38A· 1 spec - 57A 2 v - *Nucula* cf *nucleus*. Balgim DW57· 2 v - Fauna 1 5A: 1 spec.

Remarks. It may be debated whether the real *N. nucleus* is present in Southern Europe, and if most records of "*N. nucleus* " there are based on occurrences of *N. hanleyi*. The specimen fig. 23-24 from Fauna 1 38A shows the matt periostracum and convex anterior margin that characterize *N. nucleus*, and lack the coloured rays usually found on *N. hanleyi*. Other specimens and valves, lacking periostracum, are only tentatively assigned to this species.

Nucula hanleyi Winckworth, 1931
Nucula hanleyi Winckworth, 1931 - Proc. Malac. Soc. London 19: 280

Material (13-30 m). Fauna 1 22A: 1 sh. - 51A: 1 spec. (jv.) - 71A: 3 specs. (jv.)

Nucula nitidosa Winckworth, 1930 (figs. 10-12)
Nucula nitidosa Winckworth, 1930 - Proc. Malac. Soc. London 19: 14

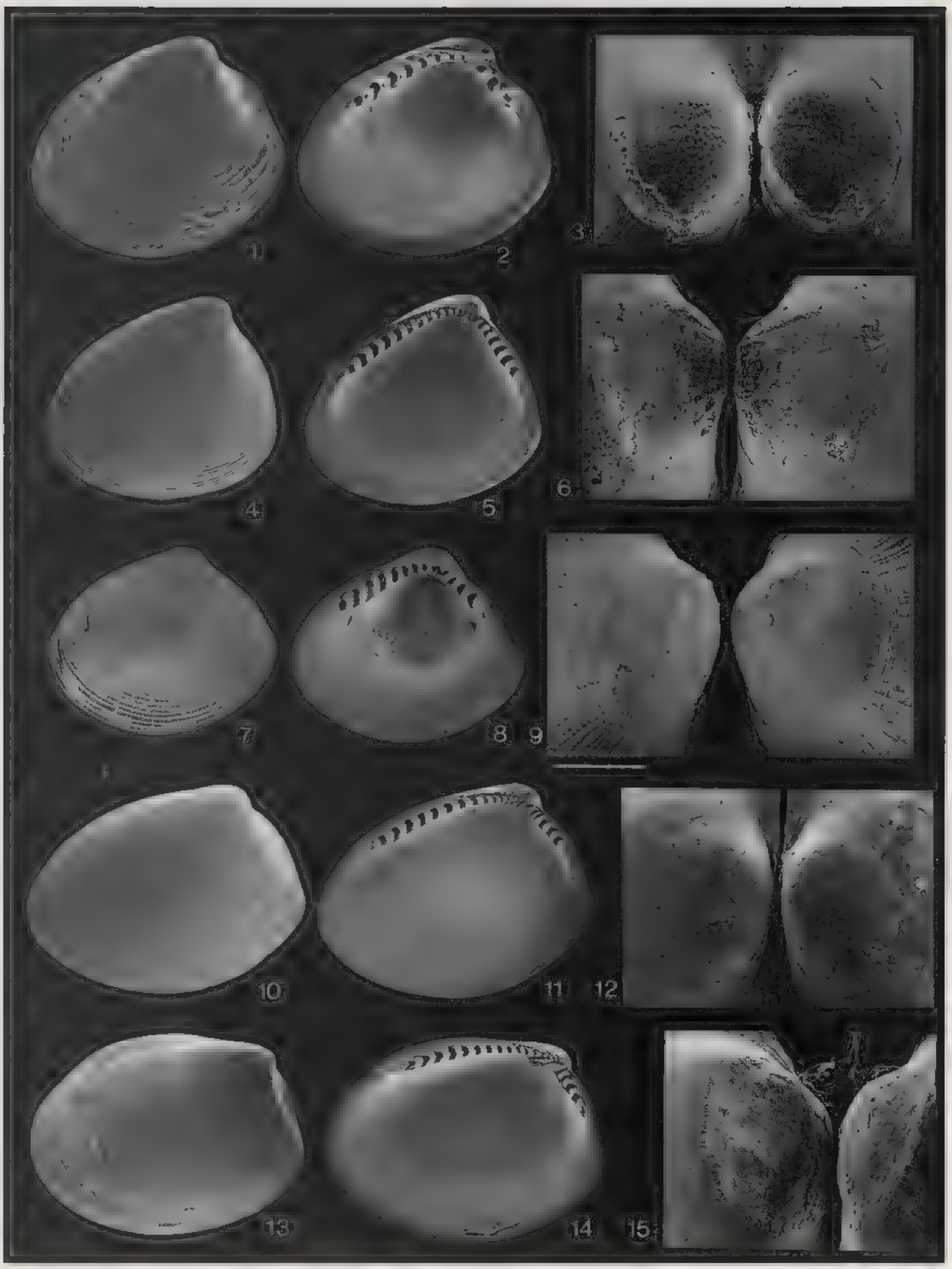
Material (25-96 m) Fauna 1 0A· 1 spec (1046) - 38A 1 spec. - 44A· 3 specs. (1104)+2 specs (1134)+10 specs. - 66A. 1 spec (1161) - 38A 2 specs. - 66A 20 specs (9 jv)+2 sh - 5A 1 sh. - 71A 645 specs + 8 v. - 71A: 11 v. (1232)

Nucula decipiens Philippi, 1844 (figs. 13-15)
Nucula decipiens Philippi, 1844 -En. Moll. Sic. 2: 48, pl 15 fig 15.

Material (373-556 m) Balgim DR23· 3 specs - DR24 1 spec - DR45· 21 v - DR136: 1 v. - DR141. 2v. - DW142: 1 v. - DR144 6 specs - CP145: 7 specs

Remarks· This little known species should be assigned to *Ennucula* because of its smooth margin, but resembles *N. nitidosa* more than any of the two other species of *Ennucula*. It shares with the former the truncated anterior margin, the very oblique ligament pit and the radial microsculpture on the early part of the teleoconch. It is provisionally retained under its original binomen until its relationships are clarified.

Figures 1-15 Shells and protoconchs of *Nucula* Exterior of left valves and interior of right valves, and protoconchs (Scale bars for protoconchs 100 µm).
1-3. *Nucula sulcata* Bronn, 1831, Balgim DW120, 425 m, juvenile specimen (2.2 mm)
4-6. *Nucula tumidula* Malm, 1860, Balgim DW11, 1523 m (5.0 mm)
7-9. *Nucula atacellana* Schenck, 1939, Balgim CP95, 1378 m (3.0 mm)
10-12 *Nucula nitidosa* Winckworth, 1930, Fauna 1 71A, 13-15 m (4.5 mm)
13-15. *Nucula decipiens* (Philippi, 1844), Balgim CP145, 373 m (5.8 mm)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Nucula sp.

Material (34-60 m): Fauna 1 33A: 11 specs. - 38A: 1 spec.

Remarks: This very small species is currently in the process of description elsewhere.

Ennucula aegeensis (Forbes, 1844) (figs. 16-18)
Nucula aegeensis Forbes, 1844 - Rep. Brit Ass. Adv. Sc. 1843: 192

Material (155-1200 m) Balgim DR01. 3 specs - DW02 42 specs. (27 jv) - CP03 2 specs +1 sh. + 1 v - DW07 9 specs - DR22 1 spec - DW24: 2 v - DW27: 7 specs (3 jv)+7 v - DW28 6 specs (2 jv) + 6 v - DW32. 14 specs. (6 jv.)+1 sh. - CP33: 5 specs. (3 jv.) - DR56. 4 specs. - DR71. 1 spec.+ 1 v - DR101: 1 spec - CP109: 1 spec - DR118 1 spec. (jv.) - DW120. 40 specs - DW121 3 specs (jv) - DW122 1 spec + 1 v - CP123 1 sh. (jv) - DW126: 6 specs. - CP127 6 specs +6 v - DW128 10 specs (Jv)+3 sh - CP135: 26 specs + 1 v - CP137 14 specs +2 sh +3 v. - DW146: 3 specs. (jv) - CP145 4 specs.+ 1 v. - DW147. 5 specs. (jv.)+2 sh
Fauna 1 76A: 1 spec. (jv)+1 v.

Remarks: This species is commonly referred to *Nuculoma* Cossmann, 1907 in the European literature. I have followed the views of Schenck (1939) and Maxwell (1988) for including it (and the following) in *Ennucula* Iredale, 1931.

Ennucula bushae (Dollfus, 1898) (figs. 19-21)
Nucula bushi Dollfus, 1898 - Rev Crit Paleozool 4. 180 (replacement name for *Nucula subovata* Verrill & Bush, 1898 (non d'Orbigny, 1850), USNM Proc. 20 (1139): 852, pl. 81 fig. 8, pl. 83 fig. 5)

Material (722-1917 m) Balgim DR06 1 v - DW07 2 specs. - DW11 6 specs - DW16 7 specs. (2 jv.) - DR23: 1 sh - CP25: 1 sh. - - DW58: 2 specs - DW61 4 specs + 17 v - CP62. 3 specs - CP63 1 spec + 9 sh + 19 v. - DW64: 18 specs +1 sh +3 v - CP68 2 specs - CP86 1 sh - DW87. 1 sh - DW88. 30 specs. - CP89 8 specs. - CP90. 39 specs.+1 sh. - CP92. 1 spec. - CP95: 1 sh. - CP99: 1 spec. - DW107: 12 specs - CP108. 1 sh

Remarks: This species is the most abundant bathyal nuculid, occurring between 700 and 2000 m on the slope if the Ibero-Moroccan gulf. It is extremely similar to, and maybe conspecific with, the Pleistocene fossil *E. corbuloides* (Seguenza, 1877) (fig. 22, coll. La Perna).

PRISTIGLOMIDAE

Microgloma pusilla (Jeffreys, 1879) (figs. 58-61)
Leda pusilla Jeffreys, 1879 - Proc. Zool. Soc. London (1879): 581, pl. 46 fig. 6

Material (740-1523 m): Balgim DW02: 1 spec. - DW11: 14 specs.+6 v. - DW88: 9 specs.

Remarks: *Leda microscopica* Jeffreys MS, Monterosato, 1875, *nomen nudum* is this species according to Warén (1980). It occurs sympatrically with the following *M. tumidula*, and differs in having a more oval outline, with less truncated anterior and posterior margins, and in having 4-5 teeth instead of 3 in each branch of the hinge. There are no transitional specimens The classification of this genus in the Pristiglomidae follows Sanders & Allen (1973) but should be critically reevaluated, as its representatives may as well be paedomorphic species related to *Yoldiella*.

Microgloma tumidula (Monterosato, 1880) (figs. 62-64)
Silicula tumidula Monterosato, 1880 - Bull. Soc. Malac. Ital 6: 56

Material (722-1523 m). Balgim DW02 2 specs - DW11. 35 specs + 12 v - DW16 8 specs +1 v. - DW89 2 specs

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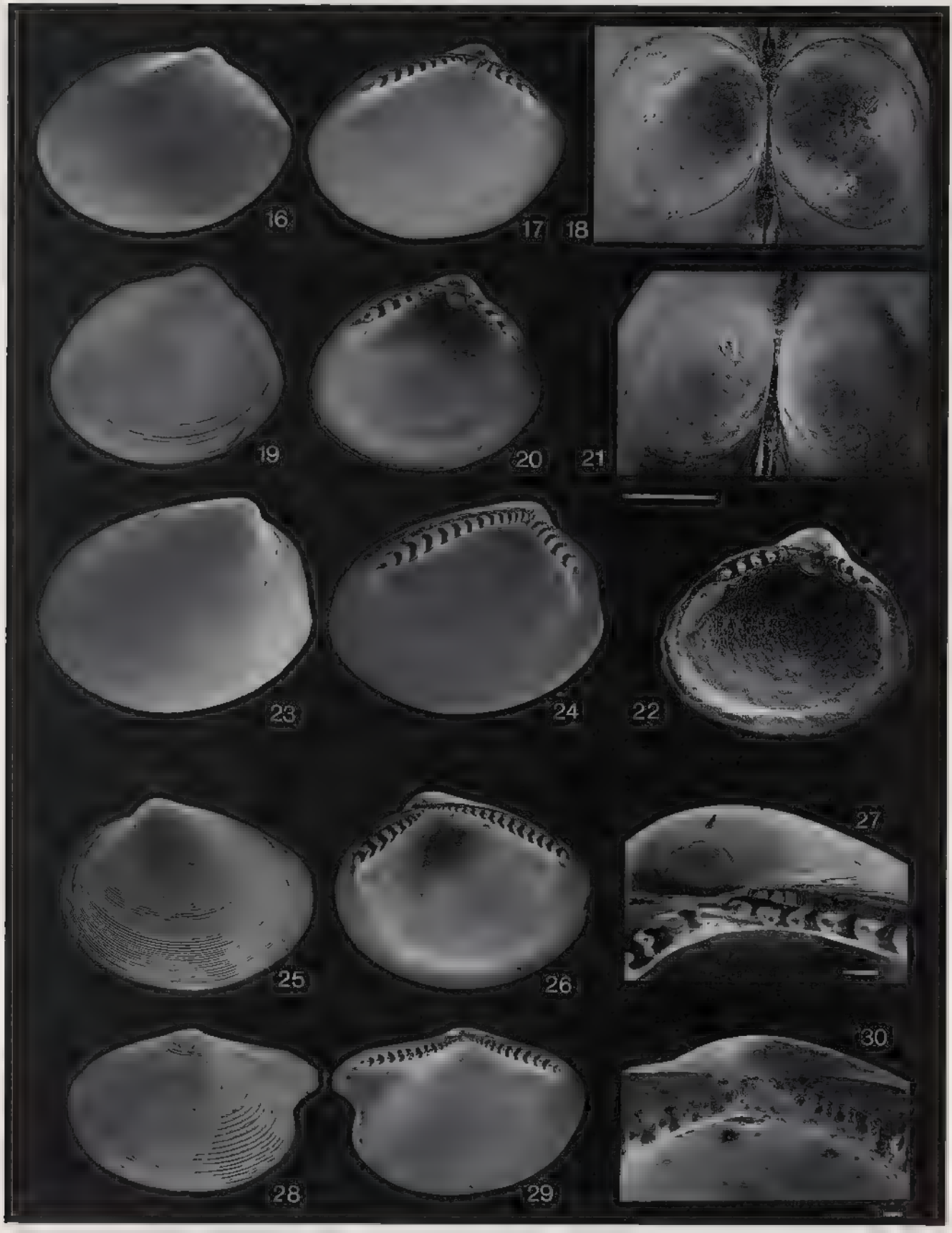
Figures 16-30 Shells and protoconchs of *Ennucula* and *Nucula*. Exterior of left valves and interior of right valves, and protoconchs (Scale bars for protoconchs 100 µm).
16-18. *Ennucula aegeensis* (Forbes, 1844), Balgim DW147, 489 m (3.7 mm)
19-21. *Ennucula bushae* (Dollfus, 1898), Balgim CP90, 890 m (2.4 mm)
22. *Ennucula corbuloides* (Seguenza, 1877), Lazzaro, Massi Nuovi (Sicily), Pleistocene fossil (3.2 mm)
23-24. *Nucula nucleus* (Linné, 1758), Fauna 1 38 A, 60-62 m (4.6 mm).

Figures 25-27 *Tindaria sericea* (Jeffreys, 1876), Balgim CP95, 1378 m Exterior of left valve and interior of right valve (4.0 mm) and detail of the hinge (Scale bar 100 µm).

Figures 28-30 *Spinula excisa* (Philippi, 1844), Balgim DR37, 864 m Interior and exterior of a left valve (7.5 mm) and detail of the hinge (scale bar 100 µm).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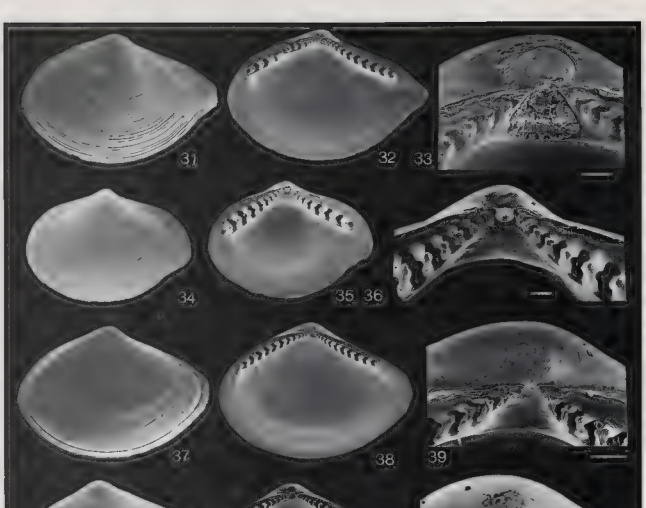
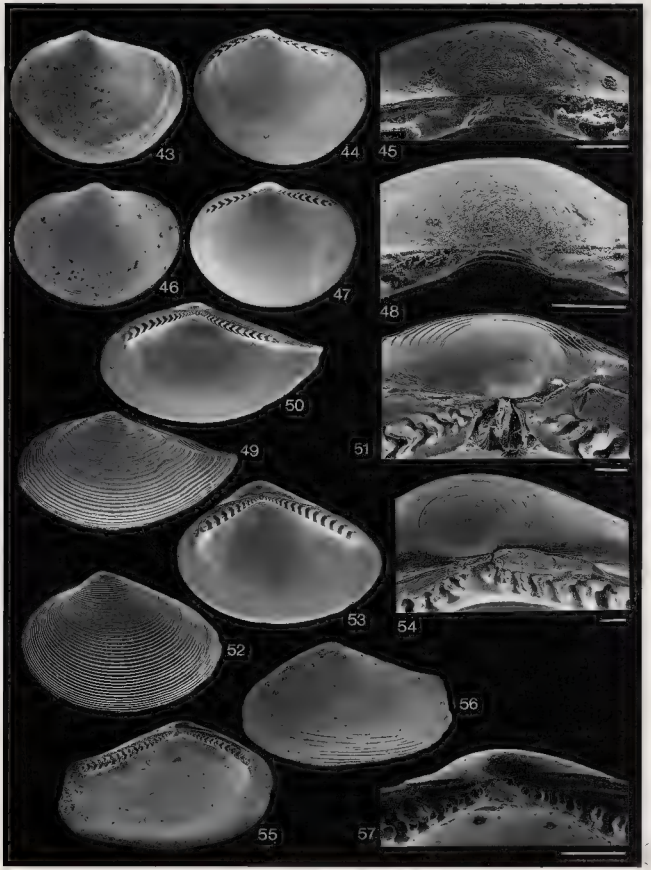


Figures 31-42. Shells and protoconchs of *Yoldiella* Exterior of left valves and interior of right valves, and details of hinges (Scale bars for hinges 100 µm).
31-33. *Yoldiella messanensis* (Jeffreys, 1870), Balgim DR22, 466 m (4 2 mm).
34-36. *Yoldiella sublevis* (Verrill & Bush, 1898), Balgim CP68, 2035 m (2.7 mm)
37-39. *Yoldiella philippiana* (Nyst, 1845), Balgim DR144, 314 m (3.7 mm).
40-42. *Yoldiella semistriata* (Jeffreys, 1879), Balgim DW07, 1141 m (3 7 mm).

Figures 43-54 Shells and protoconchs of *Yoldiella*, *Nuculana*, and *Neilonella* Exterior of left valves and interior of right valves, and details of hinges (Scale bars for hinges 100 µm).
43-45. *Yoldiella jeffreysi* (Hidalgo, 1877), Balgim CP68, 2035 m (3.3 mm).
46-48. *Yoldiella insculpta* (Jeffreys, 1879), Balgim CP68, 2035 m (2 7 mm).
49-51. *Nuculana commutata* (Philippi, 1844), Balgim CP145, 373 m (6.8 mm).
52-54. *Neilonella striolata* (Brugnone, 1876), Balgim DW11, 1523 m (4 8 mm)
Figures 55-57 *Yoldia* aff *bronni* (Bellardi, 1875), Balgim DR37, 864 m Exterior and interior of a left valve (10 mm), and detail of the hinge (scale bar 500 µm).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TINDARIIDAE

Tindaria sericea (Jeffreys, 1876) (figs. 25-27)
Leda sericea Jeffreys, 1876 - Ann Mag Nat Hist, ser. 4, 18 432-433 Proc Zool Soc London (1879). pl 46 fig 1

Material (1390-1510 m): Balgim CP63: 2 v.- CP95: 4 v.

Remarks: Warén (1989) has shown that several species were included in Jeffreys' type material. The specimens from Balgim agree with the syntype that Warén (1989, fig. 17 C-D) considered most consistent with Jeffreys' original description.

NUCULANIDAE

Spinula excisa (Philippi, 1844) (figs. 28-30)
Nucula excisa Philippi, 1844 - Enum. Moll Siciliae II. 46

Material (864 m): Balgim DR37: 1 v.

Remarks: Warén (1989, fig. 12 D-E) gave a good figure of a fossil specimen. The single valve from Balgim still has its periostracum and brings evidence that the species is still living. I have examined topotypic material from the Pleistocene of Sicily (coll. La Perna) and can see no reason to doubt the conspecificity of the fossil and recent specimens.

Nuculana commutata (Philippi, 1844) (figs. 49-51)
Nucula commutata Philippi, 1844 - Zeitschr. f. Malakozool. (1844): 101

Material (18-544 m). Balgim DW24 1 v. - CP25: 1 spec - DW27. 149 specs. + 12 v. - DW28 14 specs. - DW32: 77 specs +6 v. - CP33: 21 specs - CP34 32 specs.+ 5 v. - DR37: 1 v - DR45. 41 specs.+ 36 v - DW47: 2 specs.+ 6 v - DR70. 1 spec.+2 v - DR71: 3 sh.+ 15 v - DR72: 1 spec + 1 v - DW74 2 specs +1 v. - DR82: 1 spec - DW87: 1 spec. - DR101 1 v - DR118 1 spec +1 sh +2 v - DW120 1 spec +1 v - DW143 14 specs. - DR144: 6 specs - CP145. 1 spec. - DW146: 2 v.

Fauna 1 1A: 2 specs. - 3A: 2 specs. (1 jv.) - 5A: 1 spec + 12 v. - 13A: 2 specs (jv.) - 14A: 1 sh.+ 10 v. - 38A: 6 specs. (4 jv)+3 v. - 45A: 1 spec. - 69A: 1 spec. - Golfo de Cádiz: 1 spec.

Nuculana pella (Linné, 1758)
Arca pella Linné, 1758 - Syst. Nat., ed. 10: 693

Material (13-24 m): Fauna 1 52A: 1 v. - 71A: 1 spec

YOLDIIDAE

Yoldia aff. *bronni* (Bellardi, 1875) (figs. 55-57)
Yoldia bronni Bellardi, 1875 - Monografia delle Nuculidi trovati finora nei terreni Terziarii del Piemonte e della Liguria. Torino: 22-23, pl. 1 fig 18

Material (864 m): Balgim DR37: 1 v.

Remarks: A single valve with this distinctive sculpture and outline was recovered in a rather poor condition. It may be a subfossil or fossil specimen, and more material is needed to ascertain conspecificity with the Pliocene *Nucula bronni* Bellardi, 1875.

Figures 58-61. *Microgloma pusilla* (Jeffreys, 1879), Balgim DW11, 1523 m. 58-59. Exterior of right valve and interior of left valve (1.0 mm) 60. Detail of resilifer and part of the hinge of specimen fig 59. 61. Protoconch of another specimen (scale bar 100 µm).
Figures 62-64 *Microgloma tumidula* (Monterosato, 1880), Balgim DW11, 1523 m 62-63. Exterior of right valve and interior of left valve (0 8 mm). 64. Protoconch of another specimen (scale bar 100 µm).
Figures 65-67. *Malletia cuneata* Jeffreys, 1876, Balgim DW11, 1523 m 65-66 Exterior of the right valve and interior of a left valve (7.8 mm). 67 Detail of hinge line (scale bar 1 mm)
Figures 68-70 *Malletia johnsoni* Clarke, 1961, Balgim CP10, 1592 m 68 Exterior of a right valve (actual size 14.2 mm). 69 Interior of a left valve (light photograph of a specimen coated for SEM, actual size 14.9 mm). 70 Detail of hinge line (scale bar 1 mm).

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YOLDIELLIDAE

Yoldiella messanensis (Jeffreys, 1870) (figs. 31-33)
Leda messanensis (Seguenza, MS) Jeffreys, 1870 - Ann. Mag. Nat. Hist. 4 69.

Material (452-1805 m): Balgim DR01. 2 v. - DW02. 1 spec. (jv.) - DR06. 4 v. - DW20. 2 specs. + 2 v. - DR22. 12 specs. + 12 v. - DR23. 8 sh. + 10 v. - DW24. 5 specs. + 3 v. - DW57: 1 spec. - DW61. 4 v. - CP63. 21 specs. + 5 sh. + 1 v. - DW64. 2 specs. + 2 v. - CP65. 2 specs. - DR85: 4 v. - DW88. 1 spec. + 6 v. - CP92: 1 spec. + 4 v. - - CP95. 13 specs. + 3 sh. + 20 v. - DW96. 1 spec. + 2 v. - CP103. 1 spec. - CP123: 2 v. - DW128. 1 spec. + 2 v. - DW146. 3 specs. - DW157: 1 spec. (jv.) + 2 sh. + 20 v. - CP160: 1 spec.
Fauna 1. 38A: 1 spec. (jv.) - 73A: 1 v. - 76A: 37 specs. + 2 sh. + 43 v.

Remarks: The name *Leda messanensis* Seguenza MS in Jeffreys, 1870 has been widely used for a Pleistocene species, whereas the related Recent species was called *Leda acuminata* Jeffreys, 1870 (Warén, 1978). The distinction has been based essentially on that the fossil shells were considerably thicker than the Recent ones. The study of more material from the Lusitanian seamounts has shown a complete gradation for this character, and led Warén (1989) to unite fossil and Recent forms under the name *Yoldiella messanensis*.

Yoldiella sublevis (Verrill & Bush, 1898) (figs. 34-36)
Ledella messanensis var. *sublevis* Verrill & Bush, 1898 - Proc. U.S. Nat. Mus., 20(1139): 856, pl. 81 fig. 7

Material (2035 m): Balgim CP68: 1 spec. + 2 v.

Yoldiella philippiana (Nyst, 1845) (figs. 37-39)
Nucula philippiana Nyst, 1845 - Mem. Acad. Roy. Belg. 17: 224 (replacement name for *Nucula tenuis* Philippi, 1836, non Montagu, 1808)

Material (170-1200 m): Balgim DW20. 1 v. - DR22. 1 v. - CP25. 1 spec. - CP34. 2 v. - DR45. 3 specs. - DW47: 1 spec. - DR75. 2 specs. + 2 v. - DR79. 3 specs. + 6 v. - DR81: 5 specs. - DR82. 10 specs. + 4 v. - CP109. 11 specs. - DR118. 2 v. - DW120: 36 specs. + 9 v. - CP127: 1 spec. + 2 v. - DW128. 6 v. - DR133. 1 spec. - CP135. 4 specs. + 3 v. - DW136: 3 specs. + 18 v. - DR141: 1 spec. + 12 v. - DW142. 4 v. - DW143: 19 specs. + 2 v. - DR144. 17 specs. + 10 v. - CP145: 1 spec. + 4 v. - DR146. 110 specs. (jv.) - DW147: 3 specs. (1 jv.) + 2 v. - CP149. 1 spec.
Fauna 1. 14A. 1 spec. + 6v. - 76A: 5 v.

Remarks: According to Warén (1989), there are no reasons to doubt that the Pleistocene fossil and the Recent form are conspecific. I have examined material from the Pleistocene of Sicily (coll. La Perna) and agree.

Yoldiella semistriata (Jeffreys, 1879) (figs. 40-42)
Leda pusio var. *semistriata* Jeffreys, 1879 - Proc. Zool. Soc. London (1879): 579

Material (466-1350 m): Balgim DW07. 1 spec. + 2 v. - DW11: 2 v. - DW16. 1 v. - DR22. 1 spec. - DW61. 3 v. - CP62. 4 v. - DR85. 1 spec. - DW87. 3 specs. - DW88. 2 specs. + 2 v. - CP89. 1 spec. - CP109. 2 specs. - DW159. 6 specs. - CP160: 5 specs. + 2 v.

Yoldiella jeffreysi (Hidalgo, 1877) (figs. 43-45)
Leda jeffreysi Hidalgo, 1877 - Mol. mar. España, Portugal y las Baleares: 136. (replacement name for *Leda lata* Jeffreys, 1876 non Hinds, 1845)

Material (1523-2035 m): Balgim DW11: 2 v. - CP68: 2 specs.

Yoldiella insculpta (Jeffreys, 1879) (figs. 46-48)
Leda insculpta Jeffreys, 1879 - Proc. Zool. Soc. London (1879): 580, pl. 46 fig. 5

Material (1691-2035 m): Balgim CP68. 4 specs. + 8 v. - CP98: 1 spec. (jv.) CP99. 1 spec. - DW100. 2 v. - DW107. 1 spec. (jv.)

Yoldiella seguenzae Bonfitto & Sabelli, 1995
Yoldiella seguenzae Bonfitto & Sabelli, 1995 - J. Moll. Stud. 61: 21-27

Material (480-1523 m): Balgim DR06. 1 spec. + 14 v. - DW07. 2 v. - DW11. 1 spec. + 2 v. - DW38: 2 v. - DW58: 2 v. - DW61: 2 v. - CP62: 1 spec. + 2 v. - DW64. 2 v. - CP68. 14 v. - CP95: 2 v. - CP127. 4 v. - DW128: 1 spec. - CP137: 2 v.

Remarks: Specimens of this recently described species were identified by A. Warén. It differs from *Y. philippiana* in having a less convex postero-ventral, and more concave postero-dorsal margin, resulting in a more rostrate outline.

NEILONELLIDAE

Neilonella striolata (Brugnone, 1876) (figs. 52-54)
Yoldia striolata Brugnone, 1876 - Miscellanea Malachologica, Pars secunda: 9, pl. 1 fig 9

Material (1141-1523 m). Balgim DW11: 1 spec.+10 v - DR37. 1 v. - CP108: 4 v.

Remarks: Warén (1989) retraced the confused nomenclatural history of this species, which has resulted in the existence of many synonyms. After examination of large series of fossil and Recent specimens, he concluded to the existence of two chrono-species: *N. pusio* (Philippi, 1844) in the Lower Pliocene and *N. striolata* (Brugnone, 1876) in the Upper Pliocene, the Pleistocene and the Recent. The specimens listed here agree with those of Warén (1989: fig. 16) but admittedly Brugnone's figure shows a less inequilateral shell.

MALLETIIDAE

Malletia cuneata Jeffreys, 1876 (figs. 65-67)
Malletia cuneata Jeffreys, 1876 - Ann. Mag nat. Hist (4)18. 435-436 Proc. Zool Soc London (1879) pl 46 fig 10

Material (890-1523 m): Balgim CP10 1 v - DW11: 3 specs.+10 v - CP18 1 v - CP62 1 v - CP63 1 v - CP90 1 spec

Malletia johnsoni Clarke, 1961 (figs. 68-70)
Malletia johnsoni Clarke, 1961 - Bull. Mus. Comp. Zool. 125(12): 370-371, pl. 2 fig 6

Material (1470-1592 m): Balgim CP10: 14 v. - CP17: 1 v. - CP18: 2 specs.

Remarks: The specimens from Balgim are larger than the type material, which apparently consists of juveniles. The small differences in outline does not seem to justify a separation at species level, despite that the type locality is in Angola Basin and that the continuity of distribution is not ascertained. I have compared these specimens with topotypes of *Malletia dilatata* (Philippi, 1844) from the Pleistocene of Sicily (coll. La Perna) - the latter is a different species, characterized by a very sharp postero-dorsal angle accurately represented on Philippi's figure, and by an external sculpture of concentric ridges.

ARCIDAE

Arca noae Linné, 1758
Arca noae Linné, 1758 - Syst. Nat , ed 10. 693

Material (97-118 m). Fauna 1 60A: 1 v. - 63A: 1 spec

Arca tetragona Poli, 1795
Arca tetragona Poli, 1795 - Test. Sicil. II: 137, pl. 25 fig. 12-13

Material (30-118 m). Balgim DR37 3 v - DR42. 2 v - DR49: 5 v - DW50 1 v - DR113. 3 v. - DW114 3 v. - DR115: 3 v. - DR130: 7 v. - DW132: 4 v - DR133. 6 v. - DW134: 4 v. - DW136: 2 v. - DW142: 1 v.

Fauna 1 13A: 5 specs. (1056) - 13A: 2 specs. - 23A. 1 spec - 33A. 1 spec (jv) - 37A: 10 specs. (1119)+3 specs - 42A: 1 spec (1172) - 57A 6 specs - 58A: 1 spec. - 62A: 1 spec (1184) - 63A: 1 spec - Golfo de Cádiz: 1 spec (1258)

Barbatia barbata (Linné, 1758)
Arca barbata Linné, 1758 - Syst. Nat., ed. 10: 693

Material (24-45 m). Balgim DR115: 1 v. - Fauna 1 18A 1 spec. (1080) - 33A: 1 spec. (1180) - 51A 1 v. (1091) - 56A: 1 spec. - 58A: 1 spec. - 58A: 1 spec. (1196)

Barbatia scabra (Poli, 1795)
Arca scabra Poli, 1795 - Test. Sicil. II. 145, pl. 25 fig. 22

Material (135-550 m) Balgim DW20 2 specs. (jv) - DR22 1 v - DR23 1 v - DW24 1 v - DR37. 164 v - DR40: 3 v. - DR42. 2 specs +1 v - DR49 7 v - DW50· 4 specs +2 v. - CP135 1 v - DR152 1 spec - Fauna 1 76A· 6 v

Remarks: The identity of this species with the North Atlantic *Arca nodulosa* Müller, 1776 is debated.

Bathyarca philippiana (Nyst, 1848)
Arca philippiana Nyst, 1848 - Mem. Acad Roy Belg. 22· 54-55 (replacement name for *Arca obliqua* Philippi, 1844, Enum. Moll. Siciliae II, pl. 15 fig. 2, non Portlock nec Reeve)

Material (135-546 m)· Balgim DR19· 1 spec. - DW20 4 specs +5 v - CP21 33 specs + 1 v - DR22: 10 specs (4 jv.)+31 v. - DR23· 2 v - DW24. 6 v. - CP25. 10 specs +1 v - DR37 9 v - DR40· 3 specs + 12 v. - DR42: 1 spec. + 7 v. - DW43: 2 specs +15 v. - DW47 1 v. - DR49 1 spec (jv)+20 v - DW50· 4 specs + 15 v. - DR56. 3 v - DR72: 1 v - DR79. 1 spec (jv.) - DR81 7 specs. (6 jv.) - DR82· 7 specs (jv)+4 v - DW128· 7 specs (4 jv.)+1 sh +65 v. - DR132: 1 v. - DR133· 3 v - DW134 1 v. - CP135. 2 specs (jv)+6 v - DR141· 26 v - DW136· 30 v. - DW142: 12 v. - Fauna 1 76A: 6 specs +13 v.

Remarks: Arnaud (1978, pl. 12 fig. 225) has designated as a lectotype of *Arca grenophia* Risso, 1826 (Hist. Nat. Eur. Mérid., IV: 313) the single valve in MNHN collection, and suggested that this name should have priority over *Bathyarca pectunculoides* (Scacchi, 1834). I have examined the lectotype and found it to be conspecific with *Bathyarca philippiana* (Nyst, 1848), a view supported also by the outline of Risso's figure (in Arnaud, 1978). Since an incorrect usage (as synonym of *B. pectunculoides*) started to establish, I have proposed to ICZN to suppress the name *Arca grenophia* in order to avoid further confusion.

Bathyarca pectunculoides (Scacchi, 1834)
Arca pectunculoides Scacchi, 1834 - Ann Civ. Reg Due Sicilie, VI. 82.

Material (114-1527 m). Balgim DR06. 1 v - DW07 2 specs (1 jv) - DW16· 1 spec - DW20 4 specs. (jv.) - DR23: 1 v. - CP25: 4 specs - DW28· 1 spec (jv) - DR37 34 v (*"septentrionalis"*) - DW47· 3 specs - DR75· 6 specs - DR81 14 specs - DR82 47 specs (26 jv)+1 v - CP91 1 spec - DW96 1 spec - CP108 2 specs. (jv.) - DW120. 1 v. - DW136: 3 v (2 *"septentrionalis"* morphotype) - DW143: 1 spec (jv) - DW146: 2 specs. - DW159. 1 spec. - Fauna 1 3A: 15 specs. - 14A: 1 v. - 15A: 1 spec. - 37A. 1 v. - 57A: 1 v. - 73A: 1 v. - 76A: 4 specs.+2 v.

Remarks: An incorrect usage of the name *Bathyarca grenophia* (Risso, 1826) has started to establish for this species (see remarks under *B. philippiana*). Specimens from Balgim DR37 and DW136 all belong to a thanatocenosis and are large valves, resembling *A. pectunculoides* var. *septentrionalis* (G.O. Sars).

Bentharca asperula (Dall, 1881)
Macrodon asperula Dall, 1881 - Bull. Mus. comp. Zool. Harv. 9(2): 120.

Material (2028-2110 m): Balgim CP66· 1 spec - CP68: 6 specs. - CP69. 1 spec.

Anadara corbuloides (Monterosato, 1878)
Arca corbuloides Monterosato, 1878, Giorn Sc Nat Econ., Palermo, 13. 67 (nomen nudum) - Boll. Soc. Malac. Ital. 6: 246

Material (25-26 m): Fauna 1 44A: 2 v. (1132)

Anadara polii (Mayer, 1868)
Arca polii Mayer, 1868, Cat System descr. fossiles terr. tertiaires Mus. Zurich, 3, Moll. Arcides: 75

Material (22-240 m): Balgim CP34. 2 specs. (jv.)+1 sh +67 v.

Fauna 1 1A: 6 specs (1043) - 3A 7 specs (1037) - 3A· 4 specs. - 4A. 3 specs. (1029) - 6A: 2 specs (1072) - 12A 1 spec (1070) - 13A 3 specs. - 38A· 11 spec - 49A 4 specs (1205) - 50A· 1 spec. (1097) - 55A: 1 spec. (1251) - 57A: 9 specs. (1010)+18 specs.+4 v. - 70A. 1 spec. (1150) - Golfo de Cádiz: 2 specs.

Remarks: Oliver and Cosel (1993) have agreed with Mayer (1868) that the Recent species *A. polii* is not the same than the Miocene/Pliocene *Arca diluvii* Lamarck, 1805. The main differences are in the sculpture (ca. 33 ribs in *A. diluvii* and 24-28 in *A. polii*) and in the umbo which is more median in the fossil species.

NOETIIDAE

Striarca lactea (Linné 1758)
Arca lactea Linné, 1758 - Syst Nat , ed. 10: 694.

Material (12-150 m) Balgim DR37 2 v. - DR40 1 v - DR42 3 v. - DW43 2 v - DR49. 7 v. - DR113 10 v - DW114: 1 spec.+4 v. - DR115: 65 v. - DW116· 3 v. - DR130: 2 v. - DW132. 1 v. - DR133: 2 v. - DW136: 1 v

Fauna 1 18A· 1 sh - 22A 4 specs - 33A: 4 specs (1180)+20 specs - 52A 4 specs - 55A: 1 spec (1087) - 56A 1 spec (1245)+6 specs + 1 sh - 57A 1 spec (1009)+1 spec (1181) + 4 specs - 58A. 4 specs - 60A 3 specs - 61A 6 specs. (jv.) - 63A: 6 specs. - 66A: 8 specs. (1164)+1 spec. - 70A· 2 specs. (1156) - + 2 specs.

LIMOPSIDAE

Limopsis aurita (Brocchi, 1814) (figs. 71-73)
Arca aurita Brocchi, 1814 - Conch. Foss Subapp.: 485

Material (167-546 m): Balgim DW20: 3 specs (jv)+2 v - DR22 1 spec (jv)+11 v - DR23 14 v (1 jv) - DR37· 3 v. - DR40: 7 v - DR42· 1 sh. - DW43: 14 v - DR45: 1 sh.+ 58 v. - DW47. 3 v. - DR49: 1 sh + 4 v - CP54: 30 v - DR56 1 sh +7 v. - DR73 1 v. - DR82 1 spec (jv.)+41 v - DR101 10 v - DR113 2 v - DR115 2 v - DW128. 4 specs + 1 sh.+ 20 v. - DW132: 1 v. - DR133: 5 v. - DW134· 7 v. - CP135· 1 v - DW136· 9 sh.+160 v - DR141. 1 spec. (jv)+1 sh +175 v. - DW142: 3 specs. (jv.)+73 v. - DR144 2 v. - DW146 1 v

Fauna 1 76A: 1 spec.+9 v. - 28R· 6 v. (1054)

Remarks: I have examined specimens of *L. aurita* from the Pliocene of Northern Italy (coll. Staadt, MNHN) and from the Pleistocene of Sicily (coll. La Perna), and can see no morphological grounds for separating a fossil and a Recent species. This species is easily recognized by the smooth inner margin at all stages.

Limopsis minuta (Philippi, 1836) (figs. 74-77)
Pectunculus minutus Philippi, 1836 - En. Moll. Sic. I. 63, pl. 5 fig. 5

Material (309-1527 m)· Balgim DW20 2 specs (jv)+5 v. - DR22 9 specs.+2 sh +21 v - DR23 2 v - DW24 2 v - CP25: 1 spec +2 v. - DR37· 21v. - DR56 7 v - DW61 10 specs (7 jv)+1 sh +7 v - CP62 89 specs + 9 v - CP63 31 specs.+4 sh.+5 v - DW64 3 specs + 4 v - DR81. 1 spec (jv) - DW88 1 spec - CP89 2 specs (jv.) - CP90. 32 specs - CP91. 5 specs +36 v - CP92. 3 specs. (jv.)+1 v. - CP95 58 specs. (35 jv.)+5 v. - DW96 13 specs (11 jv)+8 v. - CP108: 24 specs. (6 jv.)+5 v. - DW157· 1 spec. - Fauna 1 76A· 11 v

Remarks: Jeffreys (1869) used the name *Limopsis borealis* Woodward ms. for the Recent representatives of this species but posteriorly (Jeffreys, 1879) considered both to be conspecific. Warén (1980) questioned this latter view and selected a neotype for *L. borealis*.

I have examined fossil specimens from the Pleistocene of Sicily (fig. 77, coll La Perna), and cannot find any essential difference with the specimens collected by Balgim expedition. *L. minuta* varies in having a more or less oblique shell, more or less crenulated inner margin, and more or less dense periostracum, but all transitions exist and the examined populations are clearly monospecific. The most diagnostic character is the existence of a cluster of more pronounced crenulations, sometimes continued inside the shell as shallow furrows, towards the posterior 2/3 of the margin.

Limopsis angusta (Jeffreys, 1879) (figs. 82-87)
Limopsis minuta var *angusta*. Jeffreys, 1879 - Proc. Zool. Soc. London (1879): 585-586

Material (395-580 m)· Balgim DR37 145 v. - DR40: 4 v - DR49 1 spec - DR50 1 v - DR53 1 v - DR130 1 v - CP135: 28 specs. (8 jv.)+1 v. - DR152· 1 spec. (jv.) - DR153: 24 specs. (2 jv.)+4 v

Remarks: The abundant material collected by Balgim allows to recognize this as a distinct species from *L. minuta*. The two species are occasionnally sympatric (DR37) but have a different habitat and life habit. *L. angusta* was found mostly on rocky substrates between 395 m (CP135) and 580 m (DR153), byssally attached. *L. minuta* was found mostly deeper than 1000 m in the Ibero-Moroccan gulf, on soft bottoms and free living or loosely attached to hexactinellid sponges.

The shell of *L. angusta* is usually notched at the outlet for the byssus, and is consistently tinged with brown towards the apex. On specimens devoid of periostracum, the concentric and

radial sculpture make a granular surface all over the outside of the shell, whereas *L. minuta* has only a limited anterior area with reticulate sculpture. Jeffreys' (1879) brief description of var *angusta* from Porcupine st. 25 (37°11' N - 9°7'W, off Sagres, 374 fathoms = ca. 680 m), was sufficient to recognize the species, and its identity was confirmed by examination of type specimens in BMNH (1885.11.5.304).

Limopsis cristata Jeffreys, 1876 (figs. 78-81)
Limopsis cristata Jeffreys, 1876 - Ann. Mag. nat Hist, ser. 4, 18: 434: 435

Material (540-1527 m): Balgim DW11: 4 specs (3 jv) - DW58: 1 spec. - DW61. 2 specs + 1 sh + 1 v. - CP62: 23 specs (8 jv)+1 v. - CP63: 1 spec. - DW64: 1 spec. (jv.)+1 v. - DW88: 2 specs. (1 jv.)+4 v. - CP89: 1 v. - CP90: 5 specs. - CP91: 13 v. - CP95: 1 spec. - DW96: 3 specs. (jv.)+1 v. - CP108: 15 specs. (6 jv.)+1 v.

Remarks: I have examined syntypes of *Limopsis cristata* from Porcupine st. 2 (BMNH11. 5. 221) to confirm the identity of this species, which is found sympatrically with *L. minuta* Philippi. It is distinguished by its smaller size, more circular outline and pattern of the periostracal hair along radial lines.

Limopsis friedbergi Glibert & van de Poel, 1965 (figs. 88-90)
Pectunculus pygmaeus Philippi, 1826 - Enum Moll Siciliae 1: 63, non Lamarck, 1819 nec Münster, 1835. - *Limopsis (Limarca) anomala friedbergi* n. nov. Glibert & van de Poel, 1965: 74-75

Material (298-864 m): Balgim DR37: 1v. - DW136: 4v.

Remarks: This species was represented in Balgim by only few worn valves, but is common in Recent material from the Canary Islands (Seamount 2 expedition, MNHN, unpublished). I have examined a syntype of Philippi (Paleontology collection of Humboldt University, Berlin, on loan to P. Bouchet in MNHN), but unfortunately this single shell is embedded in lava and only the outer side is visible. I have also examined specimens from the Pleistocene of Sicily (coll. La Perna) and cannot see more reason for separating the Recent and fossil forms, than for the other species discussed above. The replacement name proposed by Glibert and van de Poel (1965) has been overlooked by most recent checklists.

Limopsis friedbergi differs from all other species discussed here by the regularly crenulated inner margin and convex shell. *Limopsis anomala* (Eichwald, 1830) is a different species from the Miocene of Northern Europe (see Sorgenfrei, 1958 for good figures). Confusion with the Recent species has originated when Monterosato (1875) used the name *L. anomala* as a substitute for Philippi's preoccupied name.

GLYCYMERIDIDAE

Glycymeris bimaculata (Poli, 1795)
Arca bimaculata Poli, 1795 - Test. Sicil. II: 143, pl. 25 fig. 17-18

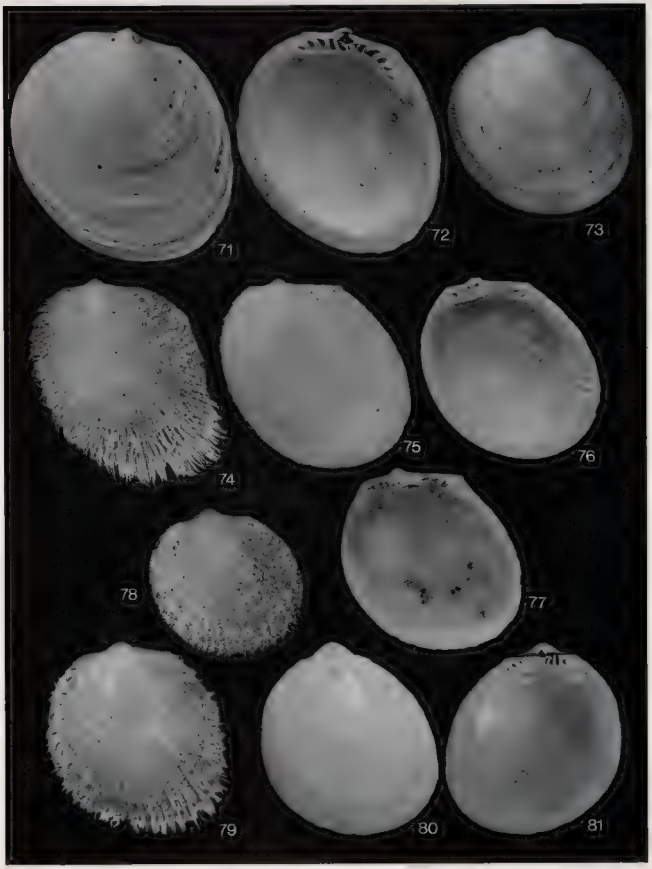
Material (transported downslope 544 m): Balgim CP25. 1 v.

Remarks: It is not clear whether this is really a distinct species from *G. glycymeris*, or only a flatter morphotype. A reappraisal of this problem is beyond the scope of this paper.

Figures 71-73 *Limopsis aurita* (Brocchi, 1814) 71. Exterior of a left valve devoid of its periostracum, Balgim DR101, 353 m (height 7.9 mm). 72. Interior of a right valve, DR101 (height 7.6 mm) 73. Exterior of a left valve with periostracum, Balgim DR42, 135 m (height 8.3 mm)

Figures 74-77 *Limopsis minuta* (Philippi, 1836) 74. Exterior of a left valve with heavy periostracum, Balgim CP91, 948 m (height 7.0 mm) 75. Exterior of a left valve with sparse periostracum, CP91 (height 6.8 mm). 76. Interior of a right valve, showing the posterior stronger grooves and crenulations, Balgim DR56, 481 m (height 6.2 mm). 77. Interior of a right valve, Pleistocene of Bovalino, Sicily (coll. La Perna, height 7.5 mm).

Figures 78-81. *Limopsis cristata* Jeffreys, 1876. 78. Exterior of the left valve of a specimen from Porcupine st. 2 (51°22'N, 12°25 W), 1470 m (808 fathoms), BMNH 1885.11.5-221 (actual height 2.4 mm) 79. Exterior of the left valve of a specimen with well-developed periostracum, Balgim CP108, 1527 m (actual height 4.8 mm). 80-81. Exterior and interior of a large left valve devoid of its periostracum, Balgim CP91, 948 m (height 6.6 mm)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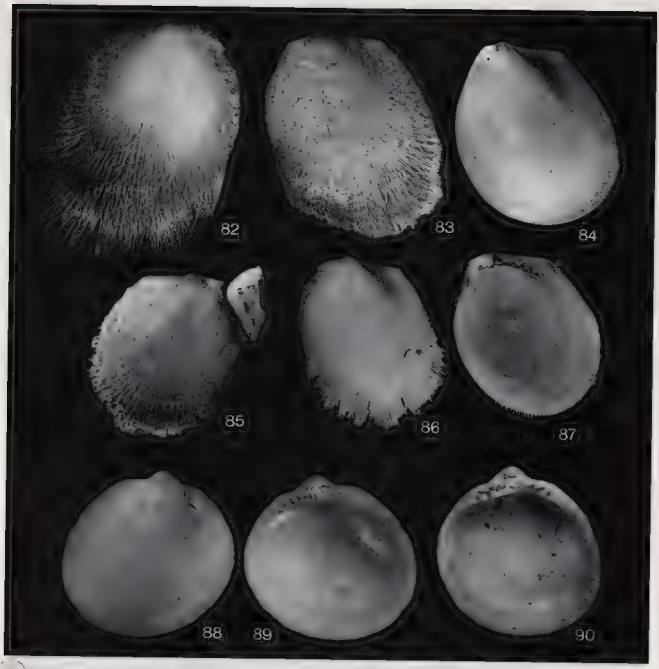


Figure 82 *Limopsis angusta* Jeffreys, 1879 Exterior of the right valve of a syntype from Porcupine st 25 (37°11'N, 9°07'W), 680 m (374 fathoms), BMNH 1885.11.5-304 (height 8.0 mm).

Figures 83-87 *Limopsis angusta* Jeffreys, 1879, Balgim DR153, 580 m 83 Exterior of a left valve (height 7.0 mm). 84 Exterior of a left valve devoid of its periostracum (height 6 9 mm) 85. Exterior of the right valve of a small specimen, byssally attached to a fragment of coral (height 3 6 mm). 86 Exterior of a left valve with rather sparse periostracum (height 5.9 mm) 87. Interior of a right valve (height 5.4 mm)

Figures 88-90. *Limopsis friedbergi* Glibert & van de Poel, 1965 88-89 Exterior and interior of a right valve, Balgim DW136, 298 m (height 5.4 mm) 90. Interior of a right valve, Pleistocene of Grammichele, Sicily (coll La Perna, height 3.5 mm).

Glycymeris glycymeris (Linné, 1758)
Arca glycymeris Linné, 1758 - Syst. Nat., ed. 10: 695

Material (24-52 m) Balgim DR42 1 sh (jv)+23 v (13 jv) - DW43: 3 v (jv) - DR71 2 v - DR72 5 v - DR73: 1 v (jv.) - DR113: 42 v (8 jv.) - DW114. 1 v (jv) - DW116 1 v. - DR130 2 v (1 jv), 1 in consolidated limestone - DW132: 4 v. - DR133: 1 v. - DW134: 2 v. - DW136: 1 v. (jv.)

Fauna 1 18A 1 spec - 22A 1 v. (1063) - 51A: 1 spec (1089) - 55A: 13 specs + 1 v (1126) - 56A 3 specs. - 58A: 1 spec. (1219) - 61A: 1 v. - 66A: 1 spec.

Remarks: *Glycymeris pilosa* (Linné, 1767) is considered only a form of *G. glycymeris* with heavier periostracum. Most material collected by Balgim has a worn, subfossil aspect.

MYTILIDAE

Mytilus galloprovincialis Lamarck, 1819
Mytilus galloprovincialis Lamarck, 1819 - An. s. vert. VI(I). 126

Material (12-24 m): Fauna 1 45A. 1 v. (1111) - 56A: 1 spec - 60A: 21 specs. (jv.)

Lithophaga lithophaga (Linné, 1758)
Mytilus lithophagus Linné, 1758 - Syst. Nat., ed. 10: 705

Material (45-52 m). Fauna 1 18A: 2 specs. (1071)

Crenella decussata (Montagu, 1808)
Mytilus decussatus G. Montagu, 1808 - Test. Brit. Suppl.: 69.

Material (181 m): Balgim DW74. 1 v.

Crenella arenaria Monterosato, 1875 ex Martin H. ms.
Crenella arenaria Martin H., ms., Monterosato, 1875 - Poche note conch. medit. 7

Material (45-74 m): Fauna 1 17A. 1 spec - 18A: 1 spec

Rhomboidella prideauxi (Leach, 1815)
Modiola prideaux Leach, 1815 - Zool. Miscell. II: 35

Material (12-118 m): Balgim DR115 1 v. - Fauna 1 14A 1 v. - 33A 16 specs +5 v - 56A. 7 specs. (4 jv) - 57A 2 v. - 60A: 4 specs. - 61A: 1 spec. - 63A: 2 specs. (jv.) - 70A: 1 spec + 1 v.

Modiolula phaseolina (Philippi, 1844) (fig. 100)
Modiola phaseolina Philippi, 1844 - En. Moll. Sic. II. 51, pl. 15 fig. 14

Material (22-523 m): Balgim DR37 4 v (large, apparently subfossil) - DR42 1 v - DW43 7 specs (jv.) - DR49: 1 spec (small)+10 v. (large, app. subfossil) - DW50. 2 specs (1 jv.)+6 v (5 subfossil) - DR113: 6 specs. (3 jv) - DW120. 1 spec. (jv) - DR130 2 specs. (jv.)+6 v - DW 132. 1 spec (jv) + 5 v - DR133 8 v. (7 large, app. subfossil) - DW134: 1 spec. (jv.)+4 v. - DW136: 4 v. (large, app. subfossil) - DR144: 1 spec (jv.)

Fauna 1 13A: 63 specs (jv.) - 17A: 20 specs - 18A. 5 specs - 22A: 17 specs - 23A 10 specs. - 33A 8 specs. + 1 v. - 37A 2 specs. (1120) - 37A. 1 spec (1179) - 37A 31 specs + 1 v - 33A 2 specs - 38A 18 specs (jv.)+37 specs. - 51A. 2 specs - 52A 2 specs. - 56A 9 specs - 57A. 27 specs +3 v - 58A 2 specs - 61A 7 specs - 63A 51 specs. + 2 specs. - 66A. 1 spec (jv.) - Golfo de Cádiz: 1 spec

Remarks: Juveniles of this species (fig. 100) resemble very much *Dacrydium* in having a hinge line with two small crenulated areas near the umbo, and a longer crenulated interval along the posterior hinge line. The two small sets of crenulations become fused in larger specimens.

Amygdalum politum (Verrill & Smith, 1880)
Modiola polita Verrill & Smith in Verrill, 1880 - Amer. Journ. Sci. 20: 392, 400

Material (508-890 m). Balgim CP89 5 specs - CP90: 1 spec - CP127 2 specs (jv) - CP148 1 spec

Amygdalum agglutinans (Cantraine, 1835)
Modiolus agglutinans Cantraine, 1835 - Bull. Ac. Roy. Sci. Belg. 2: 398

Material (22-80 m): Fauna 1 38A 1 spec (jv) - 57A: 3 specs. (1012) - 70A 1 spec (1152) - 70A 8 specs

Modiolus barbatus (Linné, 1758)
Mytilus barbatus Linné, 1758 - Syst. Nat., ed. 10: 705

Material (12-34 m): Balgim DW57: 2 v. - DR113: 2 v. - DR115. 2 v.
Fauna 1 33A: 1 spec. (1138) - 60A: 3 specs (jv.)+1 v. - 70A. 1 spec. - 72A: 1 v (1187)

Modiolus adriaticus (Lamarck, 1819)
Modiola adriatica Lamarck, 1819 - An. s. vert. 6(1): 112

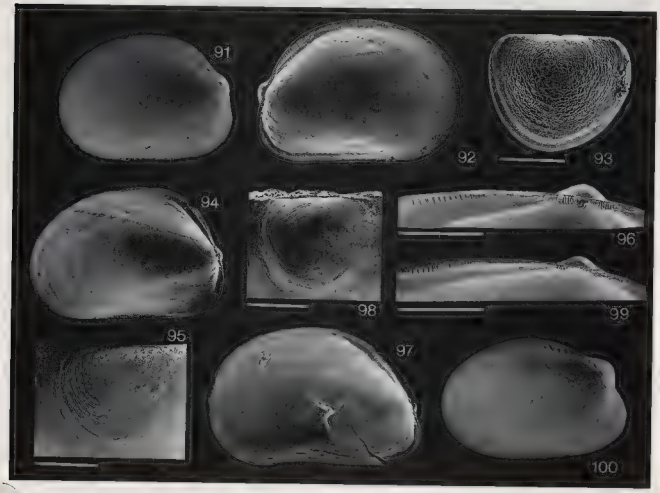
Material (13-34 m). Fauna 1: 51A: 3 sh. - 55A: 2 sh + 1 v. - 58A: 1 spec. - 70A: 2 specs. (1155) - 70A: 2 specs. + 1 v. - 71A: 2 specs. + 1 v.

Modiolarca subpicta (Cantraine, 1835)
Modiolus subpictus Cantraine, 1835 - Bull. Ac. Roy. Sci. Belg. 2: 397

Material (12-144 m): Balgim DR113: 1 spec. - Fauna 1: 13A: 4 specs (jv.) - 18A: 1 spec (jv.) - 22A: 1 spec. (jv.) - 23A: 3 specs. - 38A: 33 specs. (10 jv.) + 16 specs. - 52A: 1 spec. - 56A: 6 specs. - 57A: 1 v. - 60A: 3 specs. - 61A: 3 specs. - 70A: 6 specs. - Golfo de Cádiz: 1 spec.

Musculus costulatus (Risso, 1826)
Modiolus costulatus Risso, 1826 - H. N. Europe Mérid. 4: 324

Material (12-44 m): Fauna 1: 22A: 1 spec. - 58A: 2 specs. - 60A: 149 specs. + 1 v. - 61A: 2 specs. - I. Alborán (4 m): 1 v.



Figures 91-93. *Dacrydium hyalinum* (Monterosato, 1875). 91. Interior of a left valve, Fauna 1: 57A, 76-80 m (1.1 mm). 92. Interior of a right valve of a topotype from Palermo, ex Monterosato (1.7 mm). 93. Protoconch of an incubating larva found inside the specimen fig. 92 (215 µm; scale bar 100 µm).

Figures 94-96. *Dacrydium* cf. *hyalinum*, Balgim CP92, 1182 m. 94. Interior of a left valve (3.0 mm). 95. Protoconch of another specimen (scale bar 100 µm). 96. Hinge of the specimen fig. 94 (scale bar 500 µm).

Figures 97-99. *Dacrydium* sp., Balgim CP90, 890 m. 97. Interior of a left valve (3.3 mm). 98. Protoconch of another specimen (scale bar 100 µm). 99. Hinge of the specimen fig. 97 (scale bar 500 µm).

Figure 100. *Modiolula phaseolina* (Philippi, 1844), Fauna 1: 57A, 76-80 m. Interior of a left valve (0.85 mm).

Gregariella semigranata (Reeve, 1858)
Lithodomus semigranatus Reeve, 1858 - Conchologia Iconica, 10, *Lithodomus*. pl. 5 fig. 28 a, b
Modiola subclavata Libassi, 1859 - Memoria sopra alcune conchiglie fossili dei dintorni di Palermo· 13, fig. 7

Material (12-144 m): Balgim DR42. 1 v. - DR113· 1 spec.+1 v.

Fauna 1 5A. 1 spec - 13A· 31 specs (jv.) - 14A· 1 spec - 17A 71 specs.+1 v - 18A· 70 specs +1 v - 22A. 43 specs. - 23A: 34 specs - 33A: 47 specs +2 sh + 8 v. - 37A· 20 specs - 38A. 2 specs. (jv.) - 51A: 28 specs. - 52A. 1 spec.+1 v (associated with *Flustra*) - 56A· 10 specs - 57A. 14 specs - 58A· 10 specs. - 60A: 5 specs. (1 jv) - 61A: 18 specs. (jv) - 63A: 32 specs.+2 v. - 66A: 1 spec. (jv.) - 70A: 6 specs. - I. Alborán (4 m): 1 v.

Remarks: This name, with a description based on a specimen of unknown origin in the Cuming collection (BMNH), has precedence over *Gregariella subclavata* (Libassi, 1859). Jeffreys (1879) had already noted the synonymy but did not use the name. It is a shelf species, with a somewhat deeper habitat than *G. petagnae*.

Gregariella petagnae (Scacchi, 1832)
Mytilus petagnae Scacchi, 1832 - Lettera Test. Nap.: 7

Material (60-62 m): Fauna 1 38A: 1 spec.

Dacrydium hyalinum Monterosato, 1875 (figs. 91-93)
Dacrydium hyalinum Monterosato, 1875 - Atti Acc. Pal. Sc. Lett Arti, Palermo (2) 5: 10

Material (76-118 m). Balgim DR151: 2 specs. - Fauna 1 57A: 1 spec +1 v - 63A: 2 sh.

Remarks: This is an incubating species, found living at relatively shallow depths between 76 m (57A) and 118 m (DR151), on hard bottoms (gravel and rocks with coralline algae) whereas the other species are found deeper, on mud or ooze. A specimen from the type locality (Palermo, Sicily), collected and identified by Monterosato (Locard collection, MNHN) is figured for comparison. Incubating juveniles can also be seen in the specimen from DR151.

Dacrydium cf. *hyalinum* Monterosato, 1875 (figs. 94-96)

Material (395-1510 m) Balgim DR49· 1 spec. (jv) - DW50: 1 spec (jv) - CP62: 10 specs - CP63· 10 specs. - DW88. 1 spec. (jv) - CP92 12 specs. (1 jv.) - DW94· 1 spec (jv.) - CP95: 12 specs.+5 sh. - DW96: 1 spec. - CP108. 2 specs. (1 jv) - CP135· 4 specs. - DR153: 4 specs

Remarks: These specimens resemble the Mediterranean *Dacrydium hyalinum*, but their hinge-line is different, shorter and more delicate but also with two small crenulated areas near the umbo. They avoid the mediterranean outflow, and are certainly not conspecific with true *D. hyalinum*. This and the next species collected are in need of a revision which is beyond the scope of this paper.

Dacrydium sp. (figs. 97-99)

Material (890-2035 m). Balgim DW61· 1 spec. - CP68. 3 specs. - CP90: 2 specs

Remarks: This species somewhat resembles *Dacrydium vitreum* (Moller, 1842), a boreal species (reaching, to the South, Northern and Eastern Iceland, the Faroes and Lofoten: A. Warén, pers. comm.). A definitive identification awaits a pending revision of all Northern Atlantic *Dacrydium*.

Idas argenteus Jeffreys, 1876
Idas argenteus Jeffreys, 1876 - Ann. Mag. nat. Hist. (4)18. 428-429

Material (2028 m): Balgim CP69: 2 specs. (1 jv.)

PINNIDAE

Atrina fragilis (Pennant, 1777)
Pinna fragilis Pennant, 1777 - British Zoology 4· 97-98, fig. 80

Material (298-555 m) Balgim CP34 2 sh - DW134 1 spec - DW146. 3 specs - Fauna 1 58A. 1 sh (jv.)

Remarks: The name *A. pectinata* (Linné, 1767) is not appropriate for the European species, being described with India as the type locality (Syst. Nat., ed. 12: 1160). All the specimens collected are juveniles.

PTERIIDAE

Pteria hirundo (L., 1758)
Mytilus hirundo Linné, 1758 - Syst. Nat., ed. 10: 706

Material (60- 347 m). Balgim CP34 3 specs - DR42: 3 specs - DR70· 1 v. - DR75: 1 spec. (jv) - CP103· 1 spec. (jv) - DR113: 15 specs. (jv.) - DW114· 6 specs. (jv) - DR133: 1 spec (jv.)

Fauna 1 13A: 9 specs. (jv.) - 17A: 1 spec. (jv.) - 38A: 3 specs. (jv.) - 63A. 1 spec. (jv.)

PECTINIDAE

Pecten maximus (Linné, 1758)
Ostrea maxima Linné, 1758 - Syst. Nat , ed. 10: 696

Material (22-80 m) Fauna 1 13A. 1 spec (1067) - 44A· 3 v. (1131) - 51A· 1 v. (1093) - 57A: 1 spec (1002) - 70A: 2 specs. (1243)

Aequipecten opercularis (Linné, 1758)
Ostrea opercularis Linné, 1758 - Syst. Nat., ed. 10· 698

Material (21-100 m and transported downslope 118-180 m)· Balgim CP34. 1 v. - DW142. 1 v

Fauna 1 13A. 1 spec (1057) - 13A: 1 spec +1v (jv) - 22A. 14 specs.+5 v. - 23A· 2 specs. - 37A: 6 specs (1117)+ 3v. - 38A: 17 specs. (6 jv)+6 v. - 39A. 1 spec. (1235) - 44A: 1 spec. (1130) - 55A 6 specs (1084) - 56A. 1 spec (1242) - 57A: 16 specs (1003)+10 specs.+4 v - 58A: 1 spec (1194) - 62A 2 specs. (1183) - 63A 2 specs.+2 v - Golfo de Cadiz: 10 specs. (1253)

Remarks: All the specimens collected are smaller and more elongate than the usual Atlantic form, and would match the description of *Aequipecten audouinii* (Payraudeau, 1826), the common form in the Southern Iberian peninsula. Although both names are currently held as synonyms, I have doubts on the conspecificity of both forms and consider necessary a reevaluation of their relationships.

Aequipecten commutatus (Monterosato, 1875)
Pecten commutatus Monterosato, 1875 - Poche note conch med.: 6

Material (24-170 m)· Balgim CP34. 2 v - DR42: 31 v. - DW43: 9 v. - DR45. 1 v - DR72 1 v. - DR113: 1 spec. (jv.) +15 v. - DR130: 3 v. - DW132. 1 spec +8 v - DR133· 15 v. - DW134: 9 v. - DW136· 6 v. - DR141: 2 v. - DW142: 1 v.

Fauna 1 3A· 1 spec. (1035) - 22A 1 v - 56A. 1 spec. (1242) - 57A· 4 specs. (1004) - 57A· 1 spec.+1 v. - 62A: 7 specs. (1185)

Crassadoma multistriata (Poli, 1795)
Ostrea multistriata Poli, 1795 - Test. Sicil II: 164, pl. 28 fig. 14

Material (22-114 m): Balgim DR130: 1 v - DW132. 1 v - Fauna 1 3A: 5 specs. - 17A: 1 spec (1079) - 22A: 3 specs. (jv.) - 23A: 6 specs. (1 jv.) - 32A· 1 spec - 33A 7 specs. - 43A: 1 v (1028) - 51A: 5 specs (jv) - 55A: 1 spec. (1084) - 56A: 1 spec.+1 v. - 57A: 3 specs.+2 v. - 58A. 1 spec. - 60A: 3 v. - 70A: 1 spec.

Remarks: Bernard (1986) introduced the genus *Crassadoma* for the Eastern Pacific species *Lima gigantea* Gray, 1825 (= *"Hinnites" giganteus)*, to differenciate it from *Hinnites distortus* (Da Costa, 1778). Waller (1993), using evidence from early ontogenetic stages of the shell (protoconch and teleoconch), considers that *"Chlamys" pusio* (Linné, 1758) (=*"H " distortus*) and *"Chlamys" multistriata* (Poli, 1795) should also be included in the genus *Crassadoma* (see Waller, 1993, fig. 5).

The existence of two species, *Crassadoma pusio* (with cemented valve and a Northern distribution from Iceland and the British Isles to Portugal and to the Azores) and *C. multistriata* (byssally attached, with a broad distribution from the Mediterranean and Southern Iberian peninsula to Southern Africa) has been much debated, some authors considering that there is only one species which has a cemented valve only in the boreal part of its range. Waller (1993) stated the absence of any intermediate forms among the large amount of material examined and concluded that there are two separate species. In fact, his fig. 5 shows differences in size, shape and sculpture of the protoconchs.

Chlamys varia (Linné, 1758)
Ostrea varia Linné, 1758 - Syst. Nat., ed 10: 698

Material (20-297 m). Fauna 1 22A 2 specs - 23A 1 spec. - 26A 1 spec. - 33A 1 spec - 43A 1 spec (1028) - 44A: 1 spec (1129) - 44A. 2 specs (1105) - 51A 1 spec. (1095) - 52A 1 spec - 55A 28 specs (1082)+1 spec - 56A. 4 specs (1214)+1 spec. (1243) - 57A 1 spec (1003)+1 v (1006)+4 specs - 58A 5 specs. (1193)+2 specs - 70A: 3 specs. (1149)+1 spec.

Chlamys bruei (Payraudeau, 1826)
Pecten bruei Payraudeau, 1826 - Cat. Moll. Corse, 1826: 78, pl. 2 fig. 10-14

Material (395-521 m). Balgim CP21 3 v - DR22: 1 v - DW24: 2 v - CP25. 6 v - DR37 25 v - DR40: 244 v. - DR42. 2 v. - DR49: 2 specs.+ 23 v - DW50: 27 v - CP54. 1 v. - DR115: 2 v - DW128. 4 v - DR133. 1 v - CP135 6 specs.+20 v. - DW136. 2 v. - CP156: 2 v. - Fauna 1 28R. 2 v. (1053)

Remarks: This species is found in the Alboran Sea and seems to be linked with the Mediterranean water in the Ibero-Moroccan Gulf.

Chlamys pesfelis (Linné, 1758)
Ostrea pesfelis Linné, 1758 - Syst Nat., ed. 10: 679

Material (76-144 m): Balgim DR113: 1 v. - Fauna 1 57A: 1 spec

Chlamys flexuosa (Poli, 1795)
Ostrea flexuosa Poli, 1795 - Test. Sicil. II: 161, pl. 28 fig. 11

Material (22-42 m). Fauna 1 22A: 5 specs - 51A 1 v. (1092) - 52A: 1 v (1094)+2 v (jv) - 55A 9 specs (1083) - 70A: 1 spec (1246)+2 specs. (1151)

Pseudamussium clavatum (Poli, 1795)
Ostrea clavata Poli, 1795 - Test. Sicil II: 160, pl. 28 fig 17

Material (12-22 m): Balgim DW32. 1 v. - CP33 1 v. - CP34 10 v - DR71 1 v. - DR115 1 v - DR133: 1 v. - DW134: 1 v - DR141: 6 V. - DW142: 2 v - CP145: 3 v.

Fauna 1 28R: 1 v. (1053) - 29A: 3 v. (1212) - 49A: 2 v. (1210) - 52A: 1 spec. (jv.) - 60A: 1 spec (jv.)

Pseudamussium septemradiatum (Müller, O. F., 1776)
Pecten septemradiatus Müller O. F., 1776 - Zool. Dan. Prod.: 248

Material (468-523 m): Balgim DR23. 6 v - DW24. 7 v. - CP25: 43 v - DW28 2 v. - DR40 3 v. - DR49: 17 v - DW50: 1 spec.+5 v. - DR128. 1 spec. - CP135: 4 v.

Fauna 1 29A: 1 v. (1212) - 49A: 1 v. (1210) - 72A. 2 specs. (jv.) (1183) - 76A: 8 v. (1174)

Remarks: *P. clavatum* and *P. septemradiatum* are two closely related species which are not convincingly separated. The material was examined carefully for all details of protoconch, microsculpture and morphology of the byssal notch. I agree with Dijkstra (who has identified part of the material) to find both forms in the South of the Iberian peninsula.

Palliolum incomparabile (Risso, 1826)
Pecten incomparabilis Risso, 1826 - Hist. Nat. Europe mérid. IV: 82

Material (30-100 m). Balgim DR42: 6 v. - DW43 3 v - DR49. 1 v. - DW93: 1 spec (jv) - DW113. 18 v - DW114: 2 v. - DR115. 1 v. - DW134: 3 v

Fauna 1 0A 2 specs. (jv.)+1v - 18A: 1 spec - 23A 1 spec - 37A. 1 spec + 4 v - 38A: 2 specs (1249) - 57A: 1 spec.+4 v.

Palliolum tigerinum (Müller O. F., 1776)
Pecten tigerinus Müller O. F., 1776 - Zool. Dan. Prod.: 248

Material (155-173 m): Balgim: DR71: 1 v. - DR72: 1 v.

Palliolum striatum (Muller O. F., 1776)
Pecten striatus Müller O. F., 1776 - Zool. Dan. Prod.: 248

Material (30 m): Fauna 1 22A: 5 specs. (postlarval)+1 v.

Similipecten similis (Laskey, 1811)
Pecten similis Laskey, 1811 - Mem. Werner N. H. Soc I: 387

Material (60-544 m) Balgim DW20 14 specs (8 jv.)+1 v - DR22 1 spec - DW24 2 specs (jv) - CP25 3 specs. - DR42 8 specs. - DW43 8 v - DR72. 10 v - DR73 7 v - DW74: 3 v. - DR75. 1 spec. - DR113: 4 v. - DW114. 2 v. - DW132 2 specs (jv) - DR133 2 specs - DW134 22 specs (jv) - DW136 2 specs. (jv.)+12 v. - DR141: 5 specs. - DW142 150 specs (jv)+1 v. - DW143: 2 specs (jv) - DW146: 3 v.

Fauna 1 5A 3 v. - 15A: 1 v. - 37A 6 v - 38A: 3 specs.+1 v. - 57A: 1 spec +8 v. - 76A: 6 v.

Delectopecten vitreus (Gmelin, 1791)
Ostrea vitrea Gmelin, 1791 - Syst. Nat, ed 13 3328

Material (395-1527 m) Balgim CP03 1 v. - DW16. 1 spec - CP17: 1 spec.+1 v. - DR37. 5 v - DW58 1 v. - CP62. 3 specs.+2 v - CP63. 1 spec - CP89 1 spec - CP90: 9 specs - CP91 21 specs. + 8 v. - CP92: 7 specs - CP108. 3 specs.+2 v. - CP127 1 spec. - DW128. 1 spec +5 v. - CP135: 2 specs. - CP145 1 v.

Cyclopecten hoskynsi (Forbes, 1844)
Pecten hoskynsi Forbes, 1844 - 13th Rept Brit. Ass. Adv. Sc. (Cork, 1843): 192

Material (260-546 m) Balgim DW20 1 v - DR22 1 v - CP25 1 spec - DR79 1 spec - DW128 1 spec. - Fauna 1 76A: 2 specs.+13 v.

Parvamussium fenestratum (Forbes, 1844)
Pecten fenestratum Forbes, 1844 - 13th Rept. Brit Ass Adv. Sc. (Cork, 1843) 192

Material (135-555 m). Balgim DW20 3 specs (jv) - DR42 2 specs +15 v. - DW43. 1 spec +53 v - DW47 1 spec. - DR49. 3 v. - DW50: 2 v. - DR73 1 v. - DR113: 4 specs +3 v. - DW114: 1 v. - DR115 6 v - DW128: 8 v. - DW132: 1 spec (one valve missing)+6 v. - DR133. 8 v - DW134 5 v - DW136: 2 specs. (jv)+25 v - DW146. 1 spec. (jv)

Parvamussium lucidum (Jeffreys, 1873)
Pleuronectia lucida Jeffreys in Wyville Thompson, 1873 - The depth of the Sea: 464, fig. 78 a

Material (1870-2035 m): Balgim CP68 13 v. - CP69. 1 v. - CP99: 1 v - Fauna 1 76A: 1 v.

Propeamussium hypomeces (Dautzenberg & Fischer, 1897)
Amussium hypomeces Dautzenberg & Fischer, 1897. Mem Soc Zool France 10 195-196, pl. 5 fig. 11-12.

Material (890-1523 m): Balgim CP10 1 v - DW11: 1 spec.+3 v. - DW61 3 v - CP62 4 specs. (jv)+10 v - CP63: 1 spec - DW64 3 v - CP68 1 v - DW88: 1 v - CP90 2 specs. (jv) - CP91 1 spec + 7 v. - CP92: 1 v - DW94: 2 specs. (jv.) - CP95: 1 spec.+4 v. - DW96: 3 specs +4 v. - CP108: 15 v.

Remarks: *Cyclopecten* Verrill, 1897, *Parvamussium* Sacco, 1897 and *Propeamussium* De Gregorio, 1884 are three closely related genera, difficult to separate. According to Schein (1989) *Parvamussium* and *Propeamussium* are distinguished from *Cyclopecten* by the presence of internal radial rims, but those are formed rather late in the ontogeny and this character is not readily observable on juveniles.

The morphological characters which distinguish *Parvamussium* from *Propeamussium* are the following: Species of *Parvamussium* reach a size of ca. 1 cm, with a variable but clearly expressed, inequilateral ornamentation, a well marked byssal notch and internal rims starting quite late in the ontogeny. The species of *Propeamussium* reach several centimetres, are quite smooth, higher than long, equilateral, with symmetrical ears and no byssal notch; the internal rims start quite early in the ontogeny, near the apex. These differences seem to reflect different life histories, sedentary with byssal attachment for *Parvamussium* and free living, swimming for *Propeamussium*.

Hyalopecten undatus (Verrill, 1885)
Pecten undatus Verrill 1885 - Trans Conn. Ac Arts and Sc. 444, pl. 44 fig 21 - *Pecten fragilis* Jeffreys, 1876, non Montagu, 1808 nec Defrance, 1823

Material (1870-2028 m): Balgim CP69. 1 spec. - CP99: 1 v.

Remarks: Jeffreys' material of *Pecten fragilis* contains two forms, one of which corresponds to *Pecten undatus* Verrill, 1885 and the other to *Pecten frigidus* Jensen 1904, the latter restricted to the

Norwegian Sea and the Arctic. Schein (1989) questioned the validity of *H. frigidus*, considering that it may be an extreme variant of *H. undatus*

The species is distributed in the North Atlantic, from Greenland to the Equator, normally in deep water (Schein, 1989). *Pecten pudicus* Smith, 1885 from near Marion Island, in the Southern Indian Ocean is extremely similar and further data may show that it is the same species with a very broad distribution.

SPONDYLIDAE

Spondylus gussonii Costa O. G., 1829
Spondylus gussonii Costa O. G., 1829 - Cat. sist Test. Due Sicilie· 41

Material (395-580 m). Balgim DW128. 2 v. - CP135 2 specs.+75 v - DR152: 2 v. - DR153 4 specs +13 v.

ANOMIIDAE

Anomia ephippium Linné, 1758
Anomia ephippium Linné, 1758 - Syst. Nat., ed. 10. 701

Material (12-80 m): Balgım DR115. 2 v.

Fauna 1 24A: 1 spec. (1121) - 44A 4 specs (1128) - 52A: 1 spec (jv.) (on *Flustra*) - 55A: 8 specs. (1086) - 56A: 3 specs. (1233) - 57A. 1 spec. (1007) - 58A· 1 spec. (1198)+1 spec +1 sh +1 v - 60A· 1 spec (1234)+1 spec (jv.)+4 v. - 70A: 5 specs. (1144)+1 spec. (jv.) - 71A· 1 spec (1224)

Pododesmus patelliformis (Linné, 1761)
Anomia patelliformis Linné, 1761 - Faun. Suec., ed. 2. 521

Material (33-80 m). Fauna 1 33A. 1 spec. (1112)+2 v - 51A: 1 spec. (1237) - 55A· 3 specs. (1086) - 57A 1 spec (1007) - 58A: 1 spec.

Heteranomia squamula (Linné, 1758)
Anomia squamula Linné, 1758 - Syst Nat., ed. 10: 401

Material (18-903 m)· Balgim CP25· 4 specs. (jv.) - CP33. 1 spec. (jv.) - DR37 4 v - DR40· 5 v. - DW43· 2 specs. - DR49· 10 specs.+3 v. - DW50. 20 specs.+9 v. - DR113: 3 specs + 3 v. - DW128· 1 spec - DR130: 2 specs (jv)+2 v. - CP135 6 specs. - DW136 1 v - DW142· 1 spec (jv) - CP145. 1 spec. - DR151: 1 spec. (jv) - CP155: 3 specs. - Fauna 1 6A· 4 specs. - 45A: 1 spec. - 63A: 1 spec. - I. Alborán (4 m). 2 v.

Monia squama (Gmelin, 1791)
Anomia squama Gmelin, 1791 - Syst Nat , ed 13, I· 3346

Material (135-864 m)· Balgim DR37 14 v. - DR40 2 v. - DR42· 1 v - DW50· 1 v. - DR72: 1 v. - DR130· 4 v. - DW132: 5 v. - DR133: 3 v. - DW136: 1 v

Remarks: Material is juvenile or in poor condition.

LIMIDAE

Lima lima (Linné, 1758)
Ostrea lima Linné, 1758 - Syst. Nat., ed 10· 699

Material (18-122 m): Balgim DR42: 1 v. - DR113· 1 v. - DR115: 5 v. - DR116: 1 v
Fauna 1 17A: 1 spec. (1078) - 33A: 5 specs. (1137) - 45A· 1 spec. (1107) - 55A: 1 spec

Limaria hians (Gmelin, 1791)
Ostrea hians Gmelin, 1791 - Syst Nat., ed. 13. 3332

Material (0-195 m): Balgım DR130: 9 v (4 with subfossil aspect) - DW132: 3 v. - DR133: 4 v.
Fauna 1 I. Alborán (shore): 2 specs (1190) - Cabo Trafalgar: 1 spec

Limaria loscombii (Sowerby G. B. I, 1823)
Lima loscombi Sowerby, G. B. I - Gen Rec. Foss Shells: 17, pl. 113 fig 4

Material (150-181 m)· Balgım DR42. 6 v. - DW43: 1 spec. (jv)+10 v - DR49. 2 v - DW50. 6 v. - DW74 1 spec. - DR113: 7 v. - DW114. 6 v.

Limaria tuberculata (Olivi, 1792)
Ostrea tuberculata Olivi, 1792 - Zool. Adr.:120
Limaria inflata Link, 1807 - Beschr. Naturaliensig. Univ. Rostock, 2. 157
? Lima exilis Wood S. V., 1839 - Mag. Nat. Hist., n. s. III, 1839: 234

Material (20-80 m): Fauna 1 22A 2 specs. (jv.) - 43A 1 spec. (1019) - 57A: 3 v.

Remarks: This species has a complicated nomenclatural history following the suppression of the specific name *Limaria inflata* (Chemnitz, 1784) which had gained general acceptance. *Ostrea inflata* Gmelin, 1791 refers to another species of Chemnitz, currently known as *Limatula bullata* (Born, 1778). The following name possibly available for this species is *Ostrea tuberculata* Olivi 1792. It is based on material from the Northern Adriatic which Olivi identifies with figure FF, plate 88 of Gualteri (1642). Whereas it is not absolutely certain that Gualteri's figure represents a Mediterranean species, it is beyond doubt that, in the Mediterranean fauna, only the species formerly known as *Limaria inflata* (Chemnitz) can correspond this figure. *Limaria inflata* Link, 1807, type species of *Limaria* Link, 1807 is also based on Chemnitz's *Pecten inflatus* and makes available the specific name. It is not preoccupied by *Ostrea inflata* Gmelin, 1791 (never used in the same combination and currently not considered as congeneric). Olivi's specific name is however older and must be used in combination with the generic name *Limaria*.

Lima exilis Wood, 1839, a name which has been used for this species, is based on a Tertiary fossil of Great Britain, possibly but not certainly conspecific.

Limatula subauriculata (Montagu, 1808)
Pecten subauriculata Montagu, 1808 - Test. Brit. Suppl, 1808: 63, pl. 29 fig. 2

Material (24-118 m). Fauna 1 22A 1 spec (jv)+1 v - 56A: 10 specs +1 v. - 57A. 1 v. - 63A: 18 specs.+1 v.

Limatula gwyni (Sykes, 1903)
Lima gwyni Sykes, 1903 - Journal of Malacology 10 104 (replacement name for *Lima elliptica* Jeffreys, 1863 non Whiteaves, 1861)

Material (135-332 m). Balgim DW32 1 v - DR42: 3 v - DW43 17 v - DR45 1 v - DR113: 7 v. - DW114: 6 v. - DR115: 7 v. - DR130. 7 v. - DW132: 2 specs. (jv.)+3 v. - DR133: 1 v. - DW134. 1 v. - DW136. 1 v.

Limatula subovata (Jeffreys, 1876)
Lima subovata Jeffreys, 1876 - Ann. Mag Nat. Hist. (4)18. 427-428 - Proc Zool Soc London (1879) pl 45 fig. 2

Material (150-546 m). Balgim DR22. 1 v. - DR23. 8 v. - DW24. 2 v - DW43: 2 specs. (jv) - DW120: 1 v. - DW128: 1 v - DR130: 2 v. - DW132 2 v - DR133: 2 v - Fauna 1 73A: 1 v. - 76A. 2 specs +2 v (1 jv.)

Notolimea crassa (Forbes, 1844)
Lima (Limatula) crassa. Forbes, 1844 - 13th Rept. Brit. Ass Adv. Sc. (Cork, 1843): 193

Material (285-555 m): Balgim DW50: 3 v. - DW128: 1 v. - DW146: 1 spec.+1 v.
Fauna 1 14A: 1 v - 76A: 19 specs.+2 v.

Remarks: There is some controversy about the conspecificity of *N. crassa* (Forbes, 1844), described from the Aegean Sea, and supposedly the Mediterranean representative, and *N. sarsi* (Lovén, 1846) described from the Norwegian coast and supposedly distributed from Norway to Senegal in the Atlantic. Some authors consider them as distinct species (Tebble, 1966), subspecies (Terreni, 1980) or a single species. Jeffreys (1879) uses the name *Lima sarsi*, considering Forbes' description as insufficient and Lovén's more adequate; following this inappropriate argument, both names have been used in the literature.

I have examined the material listed above and other in MNHN from the North Atlantic, West Africa, and the Mediterranean (Sardinia), and found a gradation from the rather elongate Atlantic forms to the more subcircular Mediterranean forms. Thus, whereas no further evidence supports the distinction of two species, I will use the older name *N. crassa* for all those populations.

Notolimea clandestina Salas, 1994
Notolimea clandestina Salas, 1994 - J. Moll. Stud. 60: 249-254

Material (24-80 m): Fauna 1 56A: 1 spec. (holotype) - 57A: 1 spec. (paratype)

Remarks: This species was described after two living specimens collected by Fauna 1, and some valves in MNHN (Paris), and is considered as paedomorphic (better than neotenous as written in the original description). It is supposed to be endemic of the Strait of Gibraltar on shallow soft bottoms. Recently, for a faunal survey in Barbate, province of Cádiz, a bottom of coarse shell sand in 20 m has been sampled and has yielded many more live collected specimens in the 0.3-0.5 mm sieve fraction. Specimens were found all year round in the monthly samples, which confirms that the described specimens were adults.

OSTREIDAE

Neopycnodonte cochlear (Poli, 1795)
Ostrea cochlear Poli, 1795 - Test. Sicil. II: 179, pl. 28 fig. 28

Material (24-170 m). Balgim CP34 13 v. - DR42: 2 v. - DR49: 1 v - DR113 2 specs. (jv)+16 v - DW114. 4 v - DR115: 3 v - DR130: 12 v - DW132: 1 spec (jv)+1 v - DR133: 3 v - DW134. 1 v. - CP135 9 v. (2 large, flat) - DW136: 1 v. - DR141: 17 v. - DW142: 1 spec.+7 v. - CP145: 8 v.

Fauna 1 3A: 9 specs. (1022)+1 spec. (1036) - 4A: 20 specs. (1225) - 11A. 2 specs. (1060) - 37A 20 specs (1114) +3 specs. - 38A. 1 spec. - 42A: 2 specs (1171) - 43A: 3 specs. (1123) - 49A: 2 v. (176) - Golfo de Cádiz: 20 specs. (1225)

Ostreola stentina (Payraudeau, 1826)
Ostrea stentina Payraudeau, 1826 - Cat. Moll. Corse: 81, pl. 3 fig. 3

Material: Fauna 1 43A: 1 spec. (1124)

LUCINIDAE

Ctena decussata (Costa O. G., 1829)
Lucina decussata Costa O. G , 1829 - Descr. Zool Test. Pantelleria: 8

Material (transported downslope 332 m): Balgim DR115: 1 v.

Loripes lucinalis (Lamarck, 1818)
Amphidesma lucinalis Lamarck, 1818 - An. sans vert. 5: 491

Material (12-28 m): Fauna 1 60A. 1 sh. - 66A: 3 specs +1 v.

Remarks: This species is better known as *Loripes lacteus* (Linné, 1758), but Linné's *Tellina lactea* refers to another species (Cosel, comm. pers.).

Myrtea spinifera (Montagu, 1803)
Venus spinifera Montagu, 1803 - Test. Brit. II: 577, pl 17 fig 1

Material (281-864 m): Balgim DR37. 5 v. - DW47. 1 v. - DR118: 1 v - DW120: 6 specs.+2 sh.+5 v

Lucinoma borealis (Linné, 1767)
Venus borealis Linné, 1767 - Syst. Nat., ed. 12: 1134-1135

Material (68-548 m): Balgim DR37: 4 v. - DW57: 1 v. - DR115: 2 v. - DR130: 1 v. - CP145. 1 v.
Fauna 1 5A: 1 spec. - 38A: 1 v

THYASIRIDAE

Thyasira flexuosa (Montagu, 1803)
Tellina flexuosa Montagu, 1803 - Test. Brit. I: 72

Material (15-28 m). Fauna 1 15A: 1 v - 44A. 1 spec. - 66A: 3 specs. - 71A: 4 specs.+2 v

Thyasira perplicata **nomen novum**
Cryptodon plicatus Verrill, 1885. Trans. Connecticut Acad Arts Sci 6: 437 - Verrill & Bush, 1898, Proc. U. S. Nat. Mus. 20: 786, pl. 89 fig. 6 (non *Cryptodon plicatus* Adams, 1862)

Material (1200-1350 m): Balgim CP109. 4 v. - CP160: 2 v. (jv.)

Thyasira cf. *granulosa* (Monterosato, 1874)
Axinus granulosus Monterosato, 1874 ex Jeffreys ms · J Conchyl. 22: 251

Material (180-1523 m)· Balgim DW02: 1 spec - CP03· 1 spec. - DW07· 5 specs - DW11: 3 specs. - DW16: 11 specs. (doubtful) - DR23. 4 specs - DW24: 5 specs.+ 2 v - CP25· 2 specs - DW28· 13 specs. - DW32: 6 specs - CP33 3 specs. - CP34 9 specs - DR45 1 v. - DW53. 1 spec - DR56: 1 spec - DW61. 2 specs - DW74. 1 spec - CP86: 3 specs. - CP92: 1 spec. - DW94. 2 specs. - DW128: 1 v. - CP135: 1 spec. - CP155: 1 spec.

Thyasira succisa (Jeffreys, 1876)
Axinus incrassatus var *succisa* Jeffreys, 1876 - Ann Mag. Nat. Hist. (4)18: 492

Material (281-556 m). Balgim DR23: 1 spec. - DW47: 4 specs. - Fauna 1 76A: 1 v.

Thyasira ferruginea (Locard, 1886)
Axinus ferrugineus Locard, 1886 - Prodr. Malac. Fr.. 466 (unfustified emendation for *Kellia ferruginosa* Forbes, 1844, non Morris, 1843) - *Thyasira ferruginea* Winckworth, 1932: J. Conchol.. 19 251 (based on *Lucina ferruginosa* (Forbes, 1844) as described by Forbes & Hanley, vol. 2: 60, pl. 34 fig. 1)

Material (67-1350 m): Balgim DW27 6 specs + 1 v. - DW120· 20 specs + 22 v - CP135 6 specs. - DW147. 15 specs. - CP155 - 1 v. - DW159: 1 v. - CP160: 1 spec
Fauna 1 5A: 8 specs. - 14A: 1 spec. - 15A: 1 spec. - 76A· 5 v.

Thyasira alleni Carrozza, 1981
Thyasira alleni Carrozza, 1981: Boll. Malac 17(9-10): 223-238.

Material (147-544 m) Balgim DW24: 1 spec. - CP25: 1 spec. - DW27: 58 + 30 specs. - DW28: 106 + 16 specs. DW32: 12 specs. - CP34: 4 specs. - DR70· 2 specs - DR72· 1 spec. - DR81· 1 spec. - DR101 8 + 5 specs - DR143: 4 specs.

Thyasira subovata (Jeffreys, 1881)
Axinus subovatus Jeffreys, 1881: Proc. Zool. Soc. London 1881. 704, pl. 61 fig. 8.

Material (155-480 m) Balgim DW27· 1 spec. - DW28. 1 spec - DW32 6 specs. - DR71 1 spec - DW120: 39 specs. DW128: 48 specs. - DW143: 2 specs. - DW147. 4 specs.

Thyasira eumyaria (Sars M.,1870)
Axinus eumyarius Sars M., 1870. Christ. Fauna 2: 87, pl. 12 fig. 7-10.

Material (398-1523 m): Balgim DW07. 1 spec. - DW11. 1 spec (doubtful) - DW16: 8 specs - DW28: 1 spec. - DW120: 1 spec. (jv.) - CP123· 3 specs - DW126· 5 + 2 specs - CP137:1 + 4 specs - DW147. 1 spec. - CP155. 1 spec. - DW159. 13 specs.

Thyasira croulinensis (Jeffreys, 1847)
Clausina croulinensis Jeffreys, 1847. Ann. Mag. Nat. Hist. 20: 19.

Material (364-1360 m)· Balgim DW02: 10 specs. - DW53. 2 specs. - DW120. 9 specs. - DW126: 2 + 1 specs - DW128: 5 specs. - DW147: 17 specs +1 v. - DW159: 3 specs.

Thyasira sp.

Material (155-1141 m). Balgim DW07. 8 specs. - CP33· 2 specs. - DW53 1 spec. (?, encrusted) - DR71: 4 specs. (jv) - DW88· 6 specs. - DR118. 1 spec - DW120: 115 + 67 specs.+ 20 v - DW121 - 2 specs - CP134: 10 specs. - DW147. 26 specs.

Remarks: This may be the species treated by Allen & Payne (1991) as *Thyasira obsoleta* (Verrill & Bush, 1898).

UNGULINIDAE

Diplodonta rotundata (Montagu, 1803)
Tellina rotundata Montagu, 1803 - Test. Brit. I: 71

Material (22-332 m): Balgim DR113· 3 v. - DR115: 1 v. - Fauna 1 70A· 6 specs. (1147)

Diplodonta brocchii (Deshayes, 1852)
Lucina brochii Deshayes, 1852 - Traité elémentaire de Conchyliologie I (2): 785-786

Material (18-96 m): Fauna 1 7A: 1 spec. - 45A: 1 sh. (1109) - 57A: 2 v. (jv.)

Diplodonta apicalis Philippi, 1836
Diplodonta apicalis Philippi, 1836 - En. Moll. Sic. I: 31, pl. 4 fig. 6

Material (30-150 m): Balgim DR42. 1 sh + 113 v - DW43. 3 specs (jv.)+9 sh.+ 53 v - DR49 2 v. - DW50: 1 v. - DR113: 169 v - DW114 20 v - DR115. 19 v - DR130 18 v + 3 sh. - DW132. 19 v. - DR133. 5 sh.+ 75 v. - DW134: 9 v. - DW136. 21 v. - Fauna 1 22A. 2 specs. (jv)+1 v. - 33A: 1 spec. (jv)

CHAMIDAE

Chama gryphoides Linné, 1758
Chama gryphoides Linné, 1758 - Syst Nat., ed. 10. 692

Material (44-110 m) Balgim DR42: 16 v - DR113: 2 v - DR115 5 v. - DR130. 15 v - DW132 2 v - DR133: 8 v. - DW134: 1 v. - Fauna 1 11A: 3 specs.+2 v. - 17A: 4 specs. (1077) - 33A: 1 spec. (1140)

KELLIIDAE

Kellia suborbicularis (Montagu, 1803)
Mya suborbicularis Montagu, 1803 - Test Brit. I: 39

Material (16-290 m): Fauna 1 13A: 35 specs +3 v. - 14A: 1 spec - 17A. 11 spec +5 v - 18A 10 specs.+1c +2 v - 22A: 20 specs (jv.) - 23A: 4 specs. - 32A: 1 spec. - 33A. 13 specs.+5 v. - 37A. 2 specs - 38A: 4 specs. (3 jv.)+2 v - 51A: 2 specs. (jv.) - 56A: 17 specs + 2 v..- 57A: 2 specs + 2 v - 58A. 2 specs + 2 v - 60A: 1 spec + 1 v - 61A. 8 specs. - 63A: 17 specs. (2 in polychete tubes)+2 v. - 70A: 21 specs.+1 v.

Bornia sebetia (Costa, O. G., 1829)
Cyclas sebetia Costa O. G., 1829 - Cat. Sist. Test. Due Sicilie: 131, pl. 2 fig 6. Atti. R. Accad Sci., Zool. (Napoli) I, 1839:190

Material (18 m): Fauna 1 45A: 1 spec.

LEPTONIDAE

Hemilepton nitidum (Turton, 1822)
Lepton nitidum Turton, 1822 - Conch. Insul. Brit.: xxv and 63

Material (22-30 m): Fauna 1 22A: 1 v - 70A: 1 v.

MONTACUTIDAE

Montacuta substriata (Montagu, 1808)
Ligula substriata Montagu, 1808 - Test Brit , suppl.: 25

Material (24-112 m). Fauna 1 13A: 4 specs - 37A: 2 specs - 56A 1 spec. - 69A 1 spec. (broken)

Tellimya ferruginosa (Montagu, 1808)
Mya ferruginosa Montagu, 1808 - Test. Brit. Suppl.: 22

Material (15-28 m): Fauna 1 14A. 4 v - 60A 1 spec - 66A 1 spec. (jv) - 69A. 1 v. - 71A: 3 specs. (on *Echinocardium cordatum*)+2 v.

Mysella bidentata (Montagu, 1803)
Mya bidentata Montagu, 1803 - Test. Brit. I: 44

Material (15-546 m). Fauna 1 0A: 4 specs +5 v. - 13A: 7 specs.+1 v - 14A: 1 v - 17A. 2 v. - 22A: 1 spec. - 33A: 8 specs. - 38A. 10 specs. (4 jv) - 44A: 1 spec. - 56A: 3 specs. - 57A 1 spec. - 58A 6 specs. - 60A: 5 specs. - 61A. 5 specs. (jv.) - 63A: 2 specs - 70A: 5 specs.+1 v. - 71A. 11 spec +11 v. - 76A: 1 spec. (jv.)+1 v.

Mysella obliquata (Chaster, 1897)
Neolepton obliquatum Chaster, 1897 - Irish Nat 6: 186 (ex Monterosato 1875 nomen nudum)

Material (22-62 m): Fauna 1 38A. 1 spec. - 44A. 1 v. - 66A: 2 sh. - 70A 1 sh.

Remarks: The hinge of this species is very different from that of *Neolepton sulcatulum* (type species of *Neolepton*) and similar to that of *Mysella bidentata*, for which reason the species is here transferred to the Montacutidae.

Epilepton clarkiae (Clark, 1852)
Lepton clarkiae Clark, 1852 - Ann. Mag. Nat. Hist. (2) 9: 191

Material (13-15 m): Fauna 1 71A: 1 spec

GALEOMMATIDAE

Galeomma turtoni Sowerby G. B. I, 1825
Galeomma turtoni [Sowerby G. B. I], 1825 - Zool. Journ. 2(7): 361

Material (76-80 m): Fauna 1 57A: 1 v.

NEOLEPTONIDAE

Neolepton sulcatulum (Jeffreys, 1859)
Lepton sulcatulum Jeffreys, 1859 - Ann. Mag. Nat. Hist. (ser 3) 3: 34-35, fig. 2 a-g

Material (34-44 m): Fauna 1 33A. 3 v. - 55A 1 spec. - 61A: 2 specs

CARDITIDAE

Cardita calyculata (Linné, 1758)
Chama calyculata Linné, 1758 - Syst. Nat., ed. 10: 692

Material (26-74 m): Balgim DR42. 1 v. - DW57: 2 v - DR115. 5 v.

Fauna 1 17A 1 spec (jv) - 23A. 1 spec - 33A: 151 specs. + 3 v - 38A 1 spec - 44A: 17 specs. (1178) - I. Alborán: 1 v. (1191) - I. Alborán (4m): 3 specs.+ 4 v.

Glans aculeata (Poli, 1795)
Chama aculeata Poli, 1795 - Test. Sicil., II: 122, pl. 23 fig. 22

Material. Balgim DR42 15 v. - DW43 4 specs + 22 v. - DR113 1 sh.+ 30 v - DW114. 1 v - DR115. 5 v - DW132: 1 v. - DR141: 1 v

Fauna 1 4A. 1 spec (1030) - 57A. 2 specs + 7 v. - 58A. 1 spec. (1199) - 62A: 1 v (1189) - Golfo de Cadiz. 2 specs. (1257)

ASTARTIDAE

Astarte sulcata (Da Costa, 1778)
Pectunculus sulcatus Da Costa, 1778 - Brit. Conch.: 192

Material (80-546 m): Balgim CP21 2 v - DR22 9 v - DR23: 44 v. - DW24: 40 v. - CP25. 202 v. - DR37 187 v. - DR42. 12 v - DW42: 10 v. - DR45 1 spec. (jv.) - DR47 1 v. - DR49: 10 v - DW50 2 v - DR56 1 v - DR71 2 v - DR72 8 v - DR113. 4 v. - DR113: 35 v. - DW114: 4 v - DR115. 4 v. - DW128: 1 v. - DR130 1 v - DW132. 2 v - DR133. 4 v. - DW134: 3 v - CP135: 3 v - DW136 12 v. - DR141 9 v. - DW142. 1 spec +1 v - CP156. 3 v.

Fauna 1 28R - 2 sh (smooth margin) (1250); 37A - 1 specs + 1v. (1179), 57A: 1 spec - 76A. 1 spec.+ 7 v. - 76A: 29 v. (3 with smooth margin) (1173)

Astarte fusca (Poli, 1791)
Tellina fusca Poli, 1791: Test. Sicil. I: 49, pl. 15 fig. 33

Material (144-170 m): Balgim DR113: 1 v. - DW114: 1 v. - DR141: 1 v.

Remarks: This species differs from *A. sulcata* by the less elongate outline, more crowded concentric ridges, and by the cardinal tooth of the left valve which tends to be bifid. It is usually the commonest *Astarte* in the Mediterranean, but is hardly represented in this material.

Digitaria digitaria (Linné, 1758)
Tellina digitaria Linné, 1758. Syst. Nat , ed. 10. 677

Material (16-150 m): Balgim DR37 6 v - DR42: 3 v - DW43: 2 v. - DR49. 1 v. - DR71. 2 v. - DR72. 1 v. - DR115 4 v. - DR130: 1 spec + 13 v - DW132: 32 v. - DR133. 104 v. - DW114: 1 spec. - DW134: 11 v. - CP135: 1 v. - DW136. 72 v. - DW142 1 v

Fauna 1 22A 1 v. - 23A. 1 spec. - 38A. 1 spec (jv) - 44A 37 specs - 51A: 3 specs. (jv) - 56A: 1 v - 57A: 9 v. - 58A: 1 v. - 60A: 40 specs +1 v. - 61A: 3 specs (jv.) - 70A: 45 specs. - I. Alborán (4 m): 1 spec.

Goodallia triangularis (Montagu, 1803)
Mactra triangularis Montagu, 1803: Test. Brit. I: 99, pl. 3 fig. 5

Material (24-30 m): Fauna 1 22A: 5 specs.+ 1 sh +7 v - 56A: 3 specs.+1 v.

CARDIIDAE

Acanthocardia tuberculata (Linné, 1758)
Cardium tuberculatum Linné, 1758 - Syst. Nat., ed. 10. 679

Material (12-16 m): Fauna 1 60A 1 spec

Acanthocardia aculeata (Linné, 1758)
Cardium aculeatum Linné, 1758 - Syst Nat , ed. 10. 824, replacement name for *Cardium muricatum* Linné, 1758 - Syst Nat., ed. 10: 679 (n°62)

Material (22 m): Fauna 1 70A: 3 specs. (1148)

Acanthocardia echinata (Linné, 1758)
Cardium echinatum Linné, 1758 - Syst. Nat., ed. 10: 679

Material (80-238 m) Fauna 1 7A 1 spec (1020) - 49A: 2 v (1211) - 50A 5 v (1099) - 57A. 1 spec (1182) - 69A: 2 specs. (1239)

Remarks: The specimens recorded here correspond to the form described by Poli (1791) as *Cardium mucronatum* (Test. Sicil. I: 59), which is not proved to be conspecific with the Atlantic *A. echinata*.

Acanthocardia paucicostata (Sowerby, GB II, 1834)
Cardium paucicostatum Sowerby G. B. II, 1834 - Conchol. Illustr.: fig 20

Material (13-250 m). Balgim CP34 1 v - DW32 1 spec (jv) - Fauna 1 38A: 2 specs. - 44A. 10 specs. (1177) - 66A: 1 spec. (1167) - 70A: 3 specs (1148) - 71A: 4 specs.+ 14 v. (1223)+6 specs.+9 v

Acanthocardia spinosa (Solander, 1786)
Cardium spinosum Solander, 1786 - Cat. Portland Mus.: 16, 55, 105

Material (33-34 m): Fauna 1 58A: 1 v (1220)

Cerastoderma edule (Linné, 1758)
Cardium edule Linné, 1758 - Syst. Nat., ed. 10: 681

Material (transported downslope 256-332 m): Balgim CP33: 1 v - DR115: 3 v

Parvicardium vroomi van Aartsen, Menkhorst & Gittenberger, 1984
Cardium transversale Deshayes, 1854 - Proc Zool Soc London 22: 333; non Roemer, 1849 *Parvicardium vroomi* van Aartsen, Menkhorst & Gittenberger, 1984 - Basteria suppl. 2. 67-68

Material (4-80 m). Fauna 1 22A 2 specs - 57A: 2 specs - 60A 3 specs +7 v - I. Alborán (4m) 1 spec

Remarks: This species corresponds to *Cardium transversale* Deshayes, 1854, described from Alboran Island but preoccupied. I have examined the type material in BMNH. There are some doubts about its validity and some authors consider it as a synonym of *Parvicardium ovale* (Sowerby G. B. II, 1840).

Parvicardium scabrum (Philippi, 1844)
Cardium scabrum Philippi, 1844. Enum. Moll. Siciliae, II 38

Material (16-290 m): Balgim DR115 1 v - Fauna 1 3A 1 spec - 14A 1 spec +1 v. - 22A 21 specs +2 v - 23A. 4 specs. - 33A: 1 spec. - 56A. 1 v. - 58A· 1 spec.. 60A· 8 specs.+2 v. - 70A: 2 specs.

Remarks: There is some uncertainty as to the valid name of this well-known species. It has been often cited as "*Cardium nodosum* Turton" following Jeffreys (1863), notwithstanding that Turton (1822) did not introduce a new taxon but used the name *Cardium nodosum* Montagu, 1803 for this species. The original description of Montagu (Test. Brit. I: 81) is not very explicit and probably does not correspond to this species. *Cardium roseum* Lamarck, 1819 is possibly this species; it is beyond the scope of this paper to solve this problem and I have used the name *Parvicardium scabrum* currently accepted.

Parvicardium minimum (Philippi, 1836)
Cardium minimum Philippi, 1836. Enum. Moll. Siciliae, I: 51

Material (74-555 m)· Balgim DR23. 1 v - DW24. 5v. - DW27 1 spec (jv) - DW32. 1 spec (jv) - DR37 32 v - DR45 1 v. - DR49· 1 v - DW50. 4 v - DR71· 15 v. - DR72. 1 v - DR73 1 v - DR113 1 v. - DR115 1 v - DR118. 1 spec (jv) - CP119: 3 specs (jv) - DW120: 4 specs (jv)+8 v. - DW128· 2 v - DR134 2 specs (jv.) - DR136: 5 v - DR141· 3 v - DW142 1 spec (jv)+3 v - DW143 30 specs. (jv) - DW146 6 specs. (jv) - CP149. 1 spec

Fauna 1 0A· 2 v - 6A. 1 spec. - 15A· 7 v. (jv.) - 38A: 1 spec. - 57A: 1 v - 76A· 1 spec.+27 v

Plagiocardium papillosum (Poli, 1791)
Cardium papillosum Poli, 1791 - Test. Sicil. I. 56, pl. 16 fig. 2-4

Material (4-62 m). Balgim DR42. 1 v. - DR113· 9 v - DR115· 13 v - DW116 2 v. DR130· 3 v - DW132· 7 v - DR133· 2 v

Fauna 1 0A 1 v. - 13A: 1 spec. (jv.) - 23A 1 v - 38A· 5 specs. (jv) - 51A 1 spec. - 52A· 2 v. - 58A. 1 v. - 61A: 1 spec. - 73A· 1 v. - I. Alborán (4 m) 1 v

Laevicardium oblongum (Gmelin, 1791)
Cardium oblongum Gmelin, 1791 - Syst. Nat , ed. 13. 3254

Material (84 m): Fauna 1 7A 1 v (1021) - Golfo de Cádiz: 2 specs (1254)

Laevicardium crassum (Gmelin, 1791)
Cardium crassum Gmelin, 1791 - Syst. Nat., ed. 13: 3254

Material (16-100 m, transported downslope 144-322 m) Balgim DR113 7 v - DW114 1 spec (jv) - DR115 1 v. - DR130: 1 spec.

Fauna 1 22A. 2 specs (jv) - 37A 1 spec (1116) - 38A 8 specs (5 jv) - 44A 1 spec (jv) - 57A 3 specs (1008)+1 spec. - 60A· 2 specs. (jv.) - 70A: 16 specs. (1145) - Golfo de Cádiz: 1 spec. (jv)

MACTRIDAE

Mactra stultorum (Linné, 1758)
Cardium stultorum Linné, 1758 - Syst. Nat , ed. 10. 681

Material (15-62 m) Fauna 1 0A 1 spec - 23A 1 v - 38A 9 specs.+3 v - 60A 8 specs (jv) - 66A 1 v - 71A· 1 v. (1228) - 71A: 5 specs.

Spisula subtruncata (Da Costa, 1778)
Trigonella subtruncata Da Costa, 1778 - Brit. Conch : 198

Material (15-28 m)· Fauna 1 66A: 2 specs.+3 v. - 71A· 6 specs

Spisula solida (Linné, 1758)
Cardium solidum Linné, 1758 - Syst. Nat., ed 10: 681

Material (13-15 m): Fauna 1 71A 1 spec

Spisula elliptica (Brown, 1827)
Mactra elliptica Brown, 1827 - Ill Conch. G. B. I: pl. 15 fig. 6

Material (transported downslope 144-332 m): Balgim DR113: 2 v. - DR115: 7 v.

Lutraria angustior Philippi, 1844
Lutraria elliptica var. *angustior* Philippi, 1844 - Enum Moll. Sicil. II: 7

Material (22-25 m): Fauna 1 44A: 6 v. (1103)+1 v. - 70A: 2 v. (1158)

Lutraria magna (Da Costa, 1778)
Chama magna Da Costa, 1778 - Brit. Conch.: 230, pl. 17 fig. 4

Material (22 m): Fauna 1 70A: 1 v. (1158)

SOLENIDAE

Solen marginatus Pulteney, 1799
Solen marginatus Pulteney, 1799 - Cat. Birds & C. Dorset: 28

Material (13-15 m): Fauna 1 71A: 1 sh. (1225)

PHARIDAE

Ensis arcuatus (Jeffreys, 1865)
Solen siliqua var. *arcuata* Jeffreys, 1865 - Brit. Conch. 3: 19

Material (33-34 m): Fauna 1 58A: 1 v.

TELLINIDAE

Tellina serrata Brocchi, 1814
Tellina serrata Brocchi, 1814 - Conch. Foss. Subapp.: 510

Material (15-62 m): Fauna 1 0A. 1 spec (1240) - 4A: 1 spec. (1031) - 38A 4 specs (jv.) - 44A: 7 v (1102) - 44A. 1 sh. - 60A: 2 specs (jv.) - 66A: 1 spec +8 v. (1169) - 71A: 1 spec. (jv.)

Tellina distorta Poli, 1791
Tellina distorta Poli, 1791 - Test. Sicil. I: 39, pl. 15 fig. 11

Material (15-62 m): Fauna 1 38A: 5 specs. - 45A: 1 spec.+1 v (1110) - 60A: 1 spec. - 66A. 2 v. (1168) - 66A: 1 v. - 67A. 1 spec.+3v. (1014) - 69A: 3 v. - 71A: 1 spec.+11 v. (1229) - 71A: 28 specs.+10 v.

Tellina donacina Linné, 1758
Tellina donacina Linné, 1758 - Syst. Nat., ed. 10: 676

Material (20-181 m). Balgim DW74: 1 v. - Fauna 1 0A: 1 spec (1236) - 43A: 1 sh. (1064)

Tellina pygmaea Lovén, 1846
Tellina pygmaea Lovén, 1846 - Ofvers. K. Vet. Akad. Forh. 3(6): 196

Material (30-150 m): Balgim DW114. 1 spec. - DR133: 1 v. - Fauna 1 22A: 1 spec - 23A 2 specs. (jv.)

Remarks: It is interesting to point out the presence of an internal part of the ligament in the adult of this species, probably related with a paedomorphic evolution (see also Cosel, 1995). The three latter species are closely related and the identification of juveniles is problematic.

Tellina compressa Brocchi, 1814
Tellina compressa Brocchi, 1814 - Conch. Foss. Subapp.: 514

Material (67-78 m). Fauna 1 5A: 1 spec (1027)+1 spec. 24A: 3 specs (1073) - 38A. 6 specs. (jv.)

Arcopagia crassa (Pennant, 1777)
Tellina crassa Pennant, 1777 - Brit. Zool. 4: 87, pl. 48 fig. 28

Material (39-44 m): Fauna 1 61A: 1 v.

Arcopagia balaustina (Linné, 1758)
Tellina balaustina Linné, 1758 - Syst. Nat., ed. 10: 676

Material (170-395 m): Balgim CP34 3 v. - DR45: 4 v - DR49: 1 v. - DW50: 2 v. - DW47. 1 v. - DR70: 1 v. - DR72: 9 v. - DR73: 1 v. - DW74: 3 v - DR115: 4 v. - CP119: 3 v - DW128. 3 v - CP135: 1 spec - DR141: 1 spec. - Fauna 1 28R: 1 spec. (1052)

DONACIDAE

Donax trunculus Linné, 1758
Donax trunculus Linné, 1758 - Syst. Nat , ed 10: 682

Material (transported downslope 332 m): Balgim DR115. 2 v.

Capsella variegata (Gmelin, 1791)
Tellina variegata Gmelin, 1791 - Syst. Nat , ed. 13. 3237

Material (24 m): Fauna 1 56A: 1 spec.

PSAMMOBIIDAE

Gari costulata (Turton, 1822)
Psammobia costulata Turton, 1822 - Conch. Insul. Brt.: XXVIII and 87, pl. 6 fig. 8

Material (16-62 m; transported downslope 144-332 m): Balgim DR113: 5 v. - DR115. 1 v - DR130. 4 v. - DW132: 2 v. - DR133. 1 v.

Fauna 1 22A. 2 specs.+ 1 v - 23A 1 spec. - 33A: 1 v - 38A 2 specs. - 51A. 1 spec (jv.) - 56A. 1 spec - 60A. 6 specs. - 70A: 1 v.

Gari fervensis (Gmelin, 1791)
Tellina fervensis Gmelin, 1791 - Syst. Nat., ed. 13: 3235

Material (25-28 m): Fauna 1 66A: 1 v. (1170)

Gari tellinella (Lamarck, 1818)
Psammobia tellinella Lamarck, 1818 - Hist Nat. Anim. s. Vert 5: 515

Material (transported downslope 170-332 m): Balgim DR115: 1 v. - DW132: 1 v.

Gari pseudoweinkauffi Cosel, 1990
Gari pseudoweinkauffi Cosel, 1990 - Bull. Mus. Nat. Hist. Nat , Zool., 4e sér , 11(4): 698-700

Material (33-34 m): Fauna 1 58A: 1 v.

Remarks: This species is mainly distributed in West Africa, but reaches its Northern distributional limit in the South Iberian Peninsula. In addition to the specimen cited here, consistent populations have been collected during the faunal survey of Barbate (province of Cádiz).

SEMELIDAE

Abra prismatica (Montagu, 1808)
Ligula prismatica Montagu, 1808 - Test. Brit. Suppl.: 23, pl. 26 fig. 3

Material (13-293 m): Balgim DR45: 1 v. - Fauna 1 71A: 1 spec. (jv.)+1 v.

Abra longicallus (Scacchi, 1834)
Tellina longicallus Scacchi, 1834 - Ann. Civ. Reg. Due Sicilie 6: 79

Material (290-1470 m). Balgim DW02: 4 specs (jv.) - DR06: 1 spec.+ 12 v. - DW07: 13 specs. (5 jv.)+2 v. - CP09: 7 specs.+2 v - CP14: 20 v. - DW16: 13 specs. (10 jv)+1 v - CP17: 3 specs + 10 v - DW20: 11 v. (9 jv.) - CP21. 1 v. - DR22: 6 specs.+12 v. - DR23: 1 spec.+ 15 v. + 20 v. - DW24: 28 v. (jv) - CP25. 2 specs. (jv.)+12 v - DW27. 3 specs. (2 jv) - DW28. 6 specs. (4 jv) + 2 v. - DW32: 5 specs. (jv)+5 v. - CP33: 10 specs. (7 jv.)+11 v. - CP34. 6 v - DR45: 1 spec.+ 5 v. - DW47. 5 v. - DR49: 1 v. - DR51 2 specs. (jv.)+1 v. - DW53: 31 specs. (jv.)+2 v. - DR56: 7 specs.+3 v - CP62. 1 spec CP65: 1 v. - DR70: 3 v. - DR71: 1 spec. (jv)+10 v - DR72: 2 specs.+ 11 v. - DR73: 5 v - DW74. 1 spec.+3 v. - DR75: 2 specs.+ 1 v. - DR79: 2 specs. (jv.) - DR81: 2 specs (jv.) - DR82. 6 v. - DR85: 2 specs (jv.) - CP86. 4 specs. (jv.)+118 v. - DW87: 21 specs. (19 jv.)+16 v. - DW88: 7 specs. (jv)+3 v. - CP89: 3 specs.+ 8 v. CP90: 6 specs (4 jv.)+2 v. - CP91: 12 specs. (2 jv.)+22 v - CP92. 2 v. - DR101. 8 specs. (3 jv)+15 v CP109: 1 spec. +2 v. - DR118: 8 specs. (2 jv.) specs.+ 68 v. - CP119: 10 specs.+ 137 v - DW120: 62 specs. (jv)+49 v. (40 jv.) - DW121: 3 specs (jv.)+3 v. - DW122: 1 v. - CP123: 1 spec.+1 v. - CP124: 1 spec. - DW126: 3 specs. (2 jv.) - CP127: 1 spec.+ 79 v. - DW128: 16 specs. (6 jv)+78 v. - CP135: 28 (7 jv.) specs + 27 v. - CP137: 1 spec (jv.)+13 v - DR144: 3 v. - CP145: 6 specs.+ 48 v - DW146: 10 specs (9 jv)+3 v. - DW147: 2 specs. (2 jv.) - CP148: 3 specs + 13 v. - CP149: 4 specs.+ 38 v. - CP150: 138 v. [1 transposed]. - CP155. 5 specs (jv.)+10 v. - CP156: 1 v - DW159: 2 specs. (jv)+14 v. - CP160: 7 specs. (6 jv.)+20 v.

Fauna 1 14A: 2 specs.+1 sh + 7 v. - 15A: 1 spec - 27A 1 spec. (1066) - 28R: 3 specs. - 73A 2 v. - 76A: 2 specs + 11 v.

Abra profundorum (Smith, 1885)
Semele (Abra) profundorum Smith, 1885 - Challenger Report: 88, pl. 5 fig. 5; 5b

Material (1805-2035 m): Balgim CP65: 2 v. - CP66: 2 v. - CP68 1 spec +20 v +32 v - CP69. 3 specs.+24 v.+ 31 v. - CP99: 21 v.+37 v.

Remarks: There are valves with the rostration deviated in opposite directions, in similar proportion.

Abra alba (Wood,W., 1802)
Mactra alba Wood W., 1802 - Trans Linn. Soc. VI: 174

Material (25-170 m): Balgim DW130: 1 v. - DW132. 1 v. - Fauna 1 44A: 1 spec +2 v. - 66A: 3 v.

Abra nitida (Müller O. F., 1776)
Mya nitida Müller O. F., 1776 - Z. Dan. Prod.: 245

Material (28-352 m): Balgim DR45: 1 v. - DR118: 1 spec

Fauna 1 3A: 1 spec - 14A: 1 spec.+1 v. - 66A: 1 spec.+2 v.

Ervilia castanea (Montagu, 1803)
Donax castanea Montagu, 1803 - Test. Brit. II: 573

Material (16-44 m, valves transported downslope 144-864 m): Balgim DR37. 20 v. - DW57. 2 v. - DR113: 16 v - DW114. 1 v. - DR115: 25 v. - DW116: 3 v. - DW132: 4 v.

Fauna 1 33A: 33 specs +1 v - 56A 2 specs +1 sh +8 v - 57A: 1 v - 60A 108 specs +3 sh.+7 v - 61A: 2 v - 76A: 1 v. - I. Alborán (4 m): 1 spec

Remarks: This species, classically included in the Mesodesmatidae (Mactracea) was transferred to the Semelidae (Tellinacea) by Morton & Scott (1990), based on the presence of a ventral cruciform muscle. All the Balgim material has a subfossil aspect.

SOLECURTIDAE

Solecurtus scopula (Turton, 1822)
Psammobia scopula Turton, 1822 - Conch. Insul. Brit.: xxix, 98, 258, pl. 6 fig. 11-12

Material (25-26 m): Fauna 1 44A: 1 v. (1101) - Golfo de Cadiz. 1 sh. (1259)

Azorinus chamasolen (Da Costa, 1778)
Solen chama-solen Da Costa, 1778 - Brit. Conch.: 238

Material (25-180 m): Balgim CP34: 4 v. - DR70: 1 v. - DR71: 1 v. - DR113: 1 v
Fauna 1 3A: 1 spec. (1039) - 44A: 2 v. (1103)

ARCTICIDAE

Arctica islandica (Linné 1767)
Venus islandica Linné, 1767 - Syst. Nat., ed. 12: 1131

Material (180 m): Balgim CP34: 1 v. (subfossil)

KELLIELLIDAE

Kelliella abyssicola (Forbes, 1844)
Kellia abyssicola Forbes, 1844 - 13th Rept. Brit. Ass Adv. Sci. (Cork. 1843). 122

Material (116-1523 m): Balgim DW02 9 specs. - DR06 2 v. - DW07. 20 specs. - DW11: 1 spec. - DW16: 3 specs. - DW20: 113 specs + 2 v - DW27 65 specs - DW28. 66 specs. - DW32: 128 specs - CP33: 3 specs - DW53: 7 specs - DW61: 2 specs - DR71 4 specs +3 v - DR72 1 spec.+ 10 v - DW74. 1 spec - DR81 2 v - DW88: 5 specs - DR118: 3 specs - DW120. 85 specs +5 v. - DW121: 2 specs. - DW126. 1 spec. - DW128. 41 specs.+1 v - DW134. 1 spec. - DW143: 9 specs. - DW146: 12 specs. - DW147: 3 specs.

Fauna 1 1A 1 spec. - 3A. 3 specs - 14A: 8 specs +14 v - 15A: 3 specs + ca 100 v. - 63A 5 specs. - 76A. 22 specs. +12v. - 77A: 2 sh.

TRAPEZIIDAE

Coralliophaga lithophagella (Lamarck, 1819)
Cardita lithophagella Lamarck, 1819 - An. s. vert. VI(I): 26

Material (62-395 m). Balgim DR49 2 v - DW50: 3 v. - DR115 1 v DW128: 1 v. CP135: 2 ex. (jv.). Fauna 1 3A: 1 v. (jv.) - 38A: 2 specs. (jv.)

GLOSSIDAE

Glossus humanus (Linné, 1758)
Cardium humanum Linné, 1758 - Syst Nat , ed. 10: 682

Material (180-240 m): Balgim CP34: 1 v. - Fauna 1 49A: 1 v. (1208)

VESICOMYIDAE

Vesicomya sp.

Material (1805 m). Balgim CP65: 1 sh +5 v.

Remarks: This material belongs to an apparently undescribed species.

VENERIDAE

Globivenus effossa (Philippi, 1836)
Venus effossa Philippi ex Bivona ms, 1836 - Enum Moll. Siciliae I. 43

Material (69-172 m). Balgim DR42. 30 v - DW43: 3 v - DR113 16 v. - DR115 3 v - DR130 7 v. - DW132: 1 spec.+2 v. - DW136. 1 v. - Fauna 1 34A: 1 spec. (1241)

Remarks: The juveniles (less than 10 mm) of this species resemble *Venus casina* in the shape and disposition of the concentric lamellae; these are only somewhat more crowded. Later on, *G. effosa* adquires the peculiar undulated sculpture and lunular notch which make it unmistakable.

Venus nux Gmelin, 1791
Venus nux Gmelin, 1791 - Syst. Nat , ed. 13: 3289

Material (28-240 m): Balgim CP33: 1 v. - CP34: 4 specs. (2 jv.)+150 v - DR70: 14 v.

Fauna 1 1A: 1 spec. (1041) - 3A: 1 spec + 1 sh (1033) - 4A: 2 specs (1005) - 5A: 88 specs + 1 v. - 7A: 2 specs. (1059) - 11A: 1 spec. (1059) - 12A: 6 specs (1068) - 48A. 4 specs (1203) - 49A: 2 specs. (1206) - 50A: 4 specs. (1096)+27 specs. - 51A: 4 specs (1088) - 67A: 5 specs. (1001) - 69A: 3 specs. (1216)

Venus casina Linné, 1758
Venus casina Linné, 1758 - Syst. Nat., ed. 10: 685

Material (26-145 m): Balgim DR42: 2 v. - DW43: 8 v. - DR70: 1 v. - DR113. 3 v. - DR130: 1 spec.+3 v. - DR133: 3 v. - Fauna 1 22A: 1 spec. - 44A: 1 spec. (jv.) - 66A: 1 spec (jv)

Venus verrucosa Linné, 1758
Venus verrucosa Linné, 1758 - Syst. Nat., ed. 10: 685

Material (24 m): Fauna 1 56A: 1 spec. (1215)

Chamelea gallina (Linné, 1758)
Venus gallina Linné, 1758 - Syst. Nat., ed 10: 685

Material (transported downslope 170 m): Balgim DW132: 1 v.

Chamelea striatula (Da Costa, 1778)
Pectunculus striatulus Da Costa, 1778 - Brit Conch.: 191

Material (15-112 m): Fauna 1 0A. 1 spec (1047) - 5A: 11 spec (1018) - 5A: 7 specs.+1 v - 11A: 1 spec. (1059) - 12A: 16 specs. (1069) - 24A. 1 spec. (1074) - 38A: 1 spec - 44A. 3 specs. (1133) - 44A. 4 specs. (jv.) - 45A: 3

specs. (jv.) (1108) - 60A 2 specs. - 66A 17 specs (1163) - 66A: 5 specs. - 67A: 1 spec (1045) - 69A: 2 specs - 70A: 1 spec. (jv.) - 71A: 6 specs. (1222)+1 spec. (1248)+252 specs. (jv.)+72 v. - 72A. 1 v. (1186)

Remarks: The existence of an Atlantic species *C. striatula* distinct from the Mediterranean *C. gallina* has been much debated in the European literature. They occur sympatrically in the Southern Iberian Peninsula and there occupy different kinds of substrate, sandy for *C. gallina* and more muddy for *C. striatula*. The sympatric populations in Southern Portugal have been shown by Backeljau *et al.* (1994) to be reproductively isolated, justifying the separation of two species.

Gouldia minima (Montagu, 1803)
Venus minima Montagu, 1803 - Test. Brit. I: 121

Material (22-144 m) Balgim DR42: 26 v - DW43. 22 v. - DR72 2 v - DR113· 1 spec.+15 v - DW114: 2 v. - DR130: 7 v. - DW132. 22 v. - DR133· 20 v. - DW134· 4 v. - DW136: 18 v

Fauna 1 22A: 1 spec. (1062) - 22A 4 specs.+1 sh.+2 v - 23A 4 specs.+1 v - 33A: 2 specs - 57A· 1 spec. - 58A· 1 spec. - 70A: 1 spec. (1141) - 70A: 29 specs. (jv.)

Dosinia lupinus (Linné, 1758)
Venus lupinus Linné, 1758 - Syst. Nat , ed 10· 689

Material (15-62 m)· Balgim CP34 1 v - DR115 1 v - Fauna 1 38A 7 specs. - 60A. 13 specs +1 v. - 71A· 5 v (1231).

Dosinia exoleta (Linné, 1758)
Venus exoleta Linné, 1758 - Syst. Nat., ed. 10: 688

Material (22 m): Fauna 1 70A: 2 specs. (1146)+1 v. (1238)

Pitar rudis (Poli, 1795)
Venus rudis Poli, 1795 - Test. Sicil. II· 94, pl. 20 fig. 15-16

Material (15-22 m): Fauna 1 70A. 12 specs. (1141) - 71A: 10 v. (1226)+1 spec +2 v

Pitar cf. *rudis* (Poli, 1795)

Material (116-256 m)· Balgim CP33· 1 spec (jv.) - CP34. 17 v -, DR37: 1 v - DR42 11 v - DW43 116 v. - DR49 10 v - DW50: 6 v. - DR70· 1 spec (jv.)+12 v. - DR71 15 v (3 jv) - DR72 14 v. - DR73 1 v. - DW74: 5 v. - CP78· 3 v. - DR113. 1 spec +96 v - DW114· 21 v - DR115· 16 v. - DW116: 1 v - DR130: 2 v - DR133. 2 v. - DW134. 1 spec. (jv)+3 v. - DW136· 2 v - DR141· 1 v - DW142· 1 v. - CP145 1 v. - Fauna 1 3A· 2 specs (1038) - 22A. 2 v. - 57A: 3 v

Remarks: These specimens agree with *Pitar mediterranea* (*Cytherea mediterranea* Aradas & Benoît, 1870 ex Tiberi ms. - Conch. Viv. Sic.: 55), characterized by being totally white and having a more definite concentric sculpture. There is as yet no definitive evidence that this and *P. rudis* are different species, and I prefer to consider them as morphotypes until their taxonomy is settled.

Timoclea ovata (Pennant, 1777)
Venus ovata Pennant, 1777 - Brit. Zool. IV: 83, pl. 59 fig. 3

Material (16-555 m): Balgim DW32. 3 specs. (jv) - CP34 3 specs. (jv.)+2 v. - DR37. 6 v. - DR42. 2 specs.+33 v - DW43. 7 specs (5 jv.)+54 v - DR45 7 v. - DW47. 6 v - DR49: 3 v. - DW50 1 v - DW57: 3 v - DR70. 5 v. - DR71: 29 v. - DR72 7 v. - DR73. 11 v - DW74· 3 specs +1 v - DR75. 1 v. - DR113. 1 spec. (jv.)+89 v. - DW114. 3 specs. (jv.)+14 v. - DR115. 31 v. - DW116: 3 v. - DR130. 6 specs.+14 v. - DW132. 5 v. - DR133: 2 specs.+22 v - DW134: 5 specs. (jv.)+11 v - DW136. 20 v. - DR141. 6 specs.+31 v. - DW142. 4 specs.+8 v - DW143. 24 specs. (jv.) - DW146: 4 specs. (jv.)

Fauna 1 0A. 1 v. - 4A 4 specs - 3A· 3 specs - 5A. 3 specs. - 6A: 1 spec. - 13A. 1 spec. - 22A. 24 specs. (1 jv.)+8 v. - 23A: 1 spec.+2 v. - 24A 1 spec - 37A· 1 v - 38A· 60 specs (25 jv) - 39A 11 spec. (in guts of *Astropecten*) - 42A: 2 specs. - 57A: 2 specs +7 v. - Golfo de Cádiz: 3 specs. - 60A. 3 specs.

Clausinella fasciata (Da Costa, 1778)
Pectunculus fasciatus Da Costa, 1778 - Brit. Conch.: 188

Material (22-62 m): Fauna 1 22A 9 specs.+4 v (1065) - 23A 1 spec - 38A 1 spec - 58A 1 spec - 66A. 1 spec. (jv.) - 70A· 1 spec. (1157) - 70A· 2 specs +1 v

Tapes rhomboides (Pennant, 1777)
Venus rhomboides Pennant, 1777 - Brit. Zool IV: 83

Material (16-80 m) Balgim DR130 3 v - DW132 2 v - Fauna 1 13A 1 spec - 22A 18 specs (jv) - 23A 3 specs. - 38A· 5 specs. (jv.) - 44A 1 spec - 45A 1 spec - 55A. 3 sh (1085)+ 2 sh +1 v - 56A 2 specs (1244) - 57A 1 spec. - 58A: 2 specs (1200) + 19 specs + 9 v (1218) - 60A 13 specs (1 jv)+1 v - 61A. 5 specs (jv) - 70A. 2 specs.+ 10 sh. (1142)

Irus irus (Linné, 1758)
Donax irus Linné, 1758 - Syst. Nat., ed. 10. 683

Material (24-44 m)· Fauna 1 33A: 2 specs +1 v. - 56A: 1 spec.

PETRICOLIDAE

Mysia undata (Pennant, 1777)
Venus undata. Pennant, 1777 - Brit. Zool IV 81

Material (15-26 m)· Fauna 1 44A: 1 spec. - 66A: 1 sh (1166) - 71A. 35 v. (1230) + 3 specs.

MYIDAE

Sphenia binghami Turton, 1822
Sphenia binghami Turton, 1822 - Conch. Ins. Brit.: XVII, 36

Material (24-80 m). Fauna 1 22A. 2 specs. - 33A: 8 v. - 51A. 1 spec. - 56A: 4 specs. - 57A: 1 spec.

CORBULIDAE

Corbula gibba (Olivi, 1792)
Tellina gibba Olivi, 1792 - Zool. Adriat.: 101

Material (15-250 m): Balgim DW32· 4 specs (jv) - CP34 1 spec (jv) - Fauna 1 0A 1 spec - 3A 1 v - 6A 2 specs. - 23A: 2 v. - 38A 114 specs (jv.) - 39A· 1 spec. - 44A. 10 specs (1135) - 44A 156 specs - 45A· 4 specs. (1106) - 51A: 2 specs. (jv.)+1 v - 52A 3 specs +1v - 57A 4 v. - 66A 8 specs (1165) - 66A 80 specs. (jv)+1 sh - 69A: 13 specs. (jv.)+6 v - 70A. 1 spec (1153) - 70A. 23 specs. - 71A 16 v. (1227) - 71A 81 specs +32 v

GASTROCHAENIDAE

Gastrochaena dubia (Pennant, 1777)
Mya dubia Pennant, 1777 - Brit. Zool. IV: 69

Material (22-80 m): Fauna 1 17A· 1 spec. - 22A 1 spec. (jv.)+1 v - 33A: 1 spec. - 43A: 4 specs. (1125) - 55A· 3 specs. (1247) - 57A: 1 spec - 58A· 1 spec. (1197)+1 spec - 66A 1 spec.+1 sh. - 70A. 1 spec. (1154) + 1 spec

HIATELLIDAE

Hiatella arctica (Linné, 1767)
Mya arctica Linné, 1767 - Syst. Nat., ed. 12: 1113

Material (16-523 m)· Fauna 1 0A. 1 v - 3A· 6 specs. - 5A· 1 sh. - 6A. 1 spec (1050) - 13A: 160 specs (jv.)+2 v. - 17A· 26 specs - 18A· 14 specs. (2 jv.)+ 1 spec. (1081) - 22A: 18 specs. - 23A: 22 specs. - 33A. 20 specs.+ 1 v. - 35A: 81 specs (jv)+37 specs + 4 sh. - 37A: 4 specs (1118) + 200 specs. (jv) +1 v - 44A: 6 specs - 45A: 1 spec. - 51A: 15 specs - 52A: 6 specs + 2 v - 56A: 18 specs. - 57A· 29 specs.+9 v. - 58A· 16 specs. (1195) - 60A: 3 specs + 1 v. - 61A: 41 specs - 63A: 83 specs.+1 v - 66A. 5 specs - 70A: 35 specs + 1 sh.+ 1 spec. (1142) - I Alborán (4 m)· 1 spec. - Golfo de Cádiz: 4 specs. (1255)

Balgim CP34 1 v. - DR37· 11 v. - DR40: 18 v - DR42· 1 spec.+ 4 v - DR49: 4 v. - DW50· 2 specs.+ 2 v. - DR113: 19 specs. (5 jv)+8 v. - DR115: 1 v. - DR130: 6 v. - DW132. 3 v - DR133: 4 v. (1 jv) - CP135: 9 specs - CP137: 7 specs.+2 v. - DR151: 1 spec.

Saxicavella jeffreysi Winckworth, 1930
Saxicavella jeffreysi Winckworth, 1930 - Proc. malac. Soc. London 19: 15

Material (1283 m). Balgim DW16: 1 v.

XYLOPHAGIDAE

Xylophaga sp.

Material (38-42 m): Fauna 1 55A: Many shells in wood (1159)

Xylophaga dorsalis (Turton, 1819)
Teredo dorsalis Turton, 1819 - Conch. Dict.: 185

Material (30 m): Fauna 1 22A: 1 spec (jv.)

Xylophaga praestans Smith, 1903
Xylophaga praestans Smith, 1903 - Proc. Malac. Soc. London 5: 328-330

Material 60-62 m): Fauna 1 38A: 10 specs.+1 v

PHOLADOMYIDAE

Pholadomya loveni Jeffreys, 1882
Pholadomya loveni Jeffreys, 1882 - Proc. Zool. Soc. London (1881): 934, pl. 70 fig 7

Material (395-544 m): Balgim CP25: 4 v. - CP135: 1 v.

PANDORIDAE

Pandora inaequivalvis (Linné, 1758)
Solen inaequivalvis Linné, 1758 - Syst. Nat., ed. 10: 673

Material (13-15 m): Fauna 1 71A: 14 specs.+1 v.

Pandora pinna (Montagu, 1803)
Solen pinna Montagu, 1803 - Test. Brit. II: 566

Material (13-181 m). Balgim DW74, 1 v. - Fauna 1 38A 2 specs (jv.) - 66A: 3 specs.+ 1 v. (1162) - 67A: 1 spec (1013) - 71A: 1 spec.

LYONSIIDAE

Lyonsia norwegica (Gmelin, 1791)
Mya norwegica Gmelin, 1791, Syst. Nat., ed. 13: 3222

Material (15-24 m): Fauna 1 56A: 1 spec. (jv.) - 70A: 2 specs. (1 jv.) - 71A. 4 specs.

Allogramma formosa (Jeffreys 1882) (figs. 101-103)
Lyonsia formosa Jeffreys, 1882 - Proc. Zool. Soc London (1881): 930, pl. 70 fig. 1

Material (500-1182 m): Balgim DW07 1 spec. (jv.) - CP86: 1 spec. - DW88 1 spec (jv.) - CP91: 1 v. - CP92: 1 v.

Remarks: This is the type species of *Allogramma* Dall, 1903. Allen & Turner (1974) have included this species in the genus *Lyonsiella* G. O. Sars, 1872, without much discussion but apparently on the basis of the gill morphology with reduced or absent outer demibranch. Their material consists only of juvenile specimens, the largest of which is 8 mm long, whereas the species reaches over 20 mm in this material and then has fully developed gills.

PERIPLOMATIDAE

Cochlodesma tenerum Fischer P., 1882 (figs. 104-105)
Cochlodosma tenerum Fischer P., 1882 - J. Conchyl. 30: 53

Material (570-720 m). Balgim DW121: 1 v. - CP127: 1 spec.+1 v.

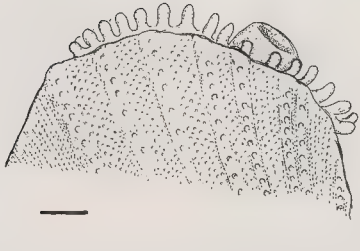


Figure 101 *Allogramma formosa* (Jeffreys, 1881), Balgim CP86, 512 m. Sketch of siphons of a living specimen (drawing by S. Gofas; scale bar 1 mm)

THRACIIDAE

Thracia distorta (Montagu, 1803)
Mya distorta Montagu, 1803 - Test Brit I. 42

Material (44 m; transported downslope 298 m): Balgim DW136: 1 v. - Fauna 1 33A: 4 specs

Thracia papyracea (Poli, 1791)
Tellina papyracea Poli, 1791 - Test. Sicil. I: 43, pl. 15 fig. 14, 18.

Material (transported downslope 145 m): Balgim DR130: 1 v.

Thracia villosiuscula (MacGillivray, 1827)
Anatina villosiuscula Macgillivray, 1827 - Edinburgh New Phil. Journ 2: 370

Material (15-22 m; transported downslope 145-155 m): Balgim DR71: 1 v. - DR130. 1 v
Fauna 1 70A: 3 specs - 71A: 5 specs

POROMYIDAE

Poromya granulata (Nyst & Westendorp, 1839) (figs. 106-108)
Corbula granulata Nyst & Westendorp, 1839 - Bull Acad Roy Sc , Bruxelles, 6(2) 398

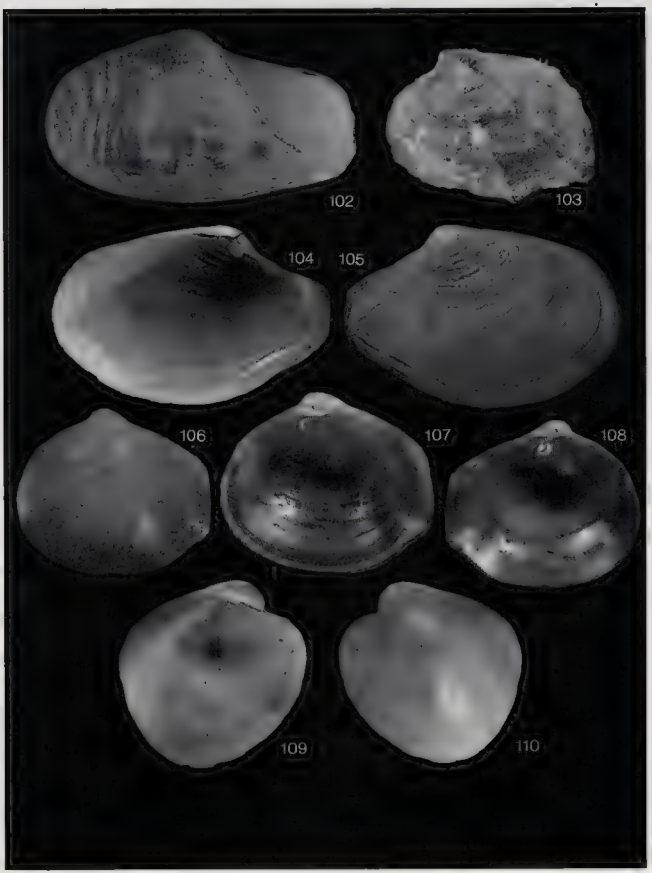
Material (155-485 m). Balgim DR42: 2 v - DR45: 26 v. - DR49. 2 v. - DW50 3 v - DR71. 1 spec. - DR72: 3 v. - DW74: 2 v. - DR82: 2 specs. - DR113. 2 v. - DR115. 1 v. - DR118: 1 v - DR128: 2 v. - CP150 1 v. - Fauna 1 76A: 1 v

Poromya neaeroides Seguenza G., 1877
Poromya neaeroides Seguenza G., 1877 - Bull. R. Comit. Geol. Ital. (4-8). 270

Material (1470 m): Balgim CP17: 1 v

Remarks: This little known species is represented only by one broken valve; the outer sculpture with radial rows of granules is characteristic.

Figures 102-103. *Allogramma formosa* (Jeffreys, 1881), exteriors from left side. 102. Adult, Balgim CP86, 512 m (18.5 mm). 103 Juvenile, Balgim DW07, 1141 m; note the apparent change in beak orientation (3.2 mm).
Figures 104-105. *Cochlodesma tenerum* Fischer, 1882, Balgim CP127, 720 m. Right valve (15.5 mm)
Figures 106-108. *Poromya granulata* (Nyst & Westendorp, 1843). 106-107. Balgim DR118, 352 m. Exterior and interior of right valve (8.2 mm). 108. Balgim DW74, 181 m Interior of left valve (8.5 mm).
Figures 109-110. *Polycordia gemma* (Verrill, 1880), Balgim DR118, 352 m Left valve (height 5.5 mm).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CUSPIDARIIDAE

Cuspidaria cuspidata (Olivi, 1792) (figs. 115-116)
Tellina cuspidata Olivi, 1792 - Zool. Adriat.: 101, pl. 4 fig 3

Material (180-370 m) Balgim CP25. 1 v. - DW27: 1 spec. (jv) - DW32· 1 spec.+ 1 v. - CP33· 2 specs (jv)+2 v. - CP34·3 specs. (jv)+1 v. - DW45 13 v. - DW47· 1 v. (jv) - DR49 2 v. - DW53· 2 specs. (jv) - DR70. 1 v. - CP78: 1 v - DR79 1 spec. (jv.)+1 v - DR82 1 spec. (jv.) - DR118 1 spec (jv.)+4 v. - CP119· 1 v. - DW120 1 v. (jv.) - DW128·1 v. - DW134. 8 specs (jv)+1 v (jv.) - CP135 1 v - DW142· 1 v. - DW143· 1 spec. (jv.) - CP148: 1 v. - CP149. 3 v. - Fauna 1 28R: 1 v. (1052) - 67A: 1 v. (1016)

Cuspidaria wollastoni (Smith, 1885) (figs. 111-112)
Neaera wollastoni Smith, 1885 - Challenger Rep. 13: 40, pl. 10 fig. 6 a-b

Material (1182-2028 m): Balgim CP10: 1 v. - CP18: 2 specs. - CP63: 1 spec - CP69. 1 v. - CP92. 1 v

Cuspidaria rostrata (Spengler, 1793) (figs. 113-114)
Mya rostrata Spengler, 1793 - Skr. nat. Selsk. (Copenhague) III(1): 42

Material (173-1163 m)· Balgim DR22. 2 specs - CP33. 1 v. - CP34: 1 spec.+ 2 v. - DW50: 1 v. - - DR71: 3 v. - DR72 1 spec + 4 v. - DR73 1 v. - DW74 4 v. - CP78 1 spec+1 v. - DR82. 2 specs + 3 v. - DW88. 1 spec.+ 1 v - CP89 1 spec - DR113 2 v. - DR115·1 v - DR118. 2 v - DW120 1 spec+1 v - DW128: 2 specs +6 v - DR133· 1 spec - CP135. 1 spec (jv) - DW136 1 spec.+ 2 v - CP137 1 spec - CP145 2 v - DW146 2 specs. (jv.) - CP149· 2 specs. - Fauna 1 3A: 1 v. (1040) - 28R: 1 spec.+3 v. (1052) - 50A. 1 v. (1200)

Cuspidaria ventricosa Verrill & Bush, 1898 (figs. 117-118)
Cuspidaria ventricosa Verrill & Bush, 1898 - Proc. U S nat Mus 20 802, pl 72 fig 5, pl 76 fig 6

Material (1592 m): CP10. 1 spec

Cuspidaria sulcifera (Jeffreys, 1882)
Neaera sulcifera Jeffreys, 1882 - Proc. Zool. Soc. London (1881): 937, pl. 70 fig. 10

Material (890-1350 m): Balgim CP90· 9 specs. (jv.) - CP160 1 spec. (jv.) - Fauna 1 76A: 1 v.

Cuspidaria teres (Jeffreys, 1882) (figs. 119-120)
Neaera teres Jeffreys, 1882 - Proc. Zool Soc. London (1881): 939, pl. 71 fig. 2

Material (948-1510 m): Balgim CP63: 1 v CP91. 2 v.+2 cf. - CP92· 1 v. - - CP95· 4 v. - DW96 2 v.

Cuspidaria inflata (Jeffreys, 1882) (figs. 121-122)
Neaera inflata Jeffreys, 1882 - Proc. Zool. Soc. London (1881): 942, pl. 71 fig. 8

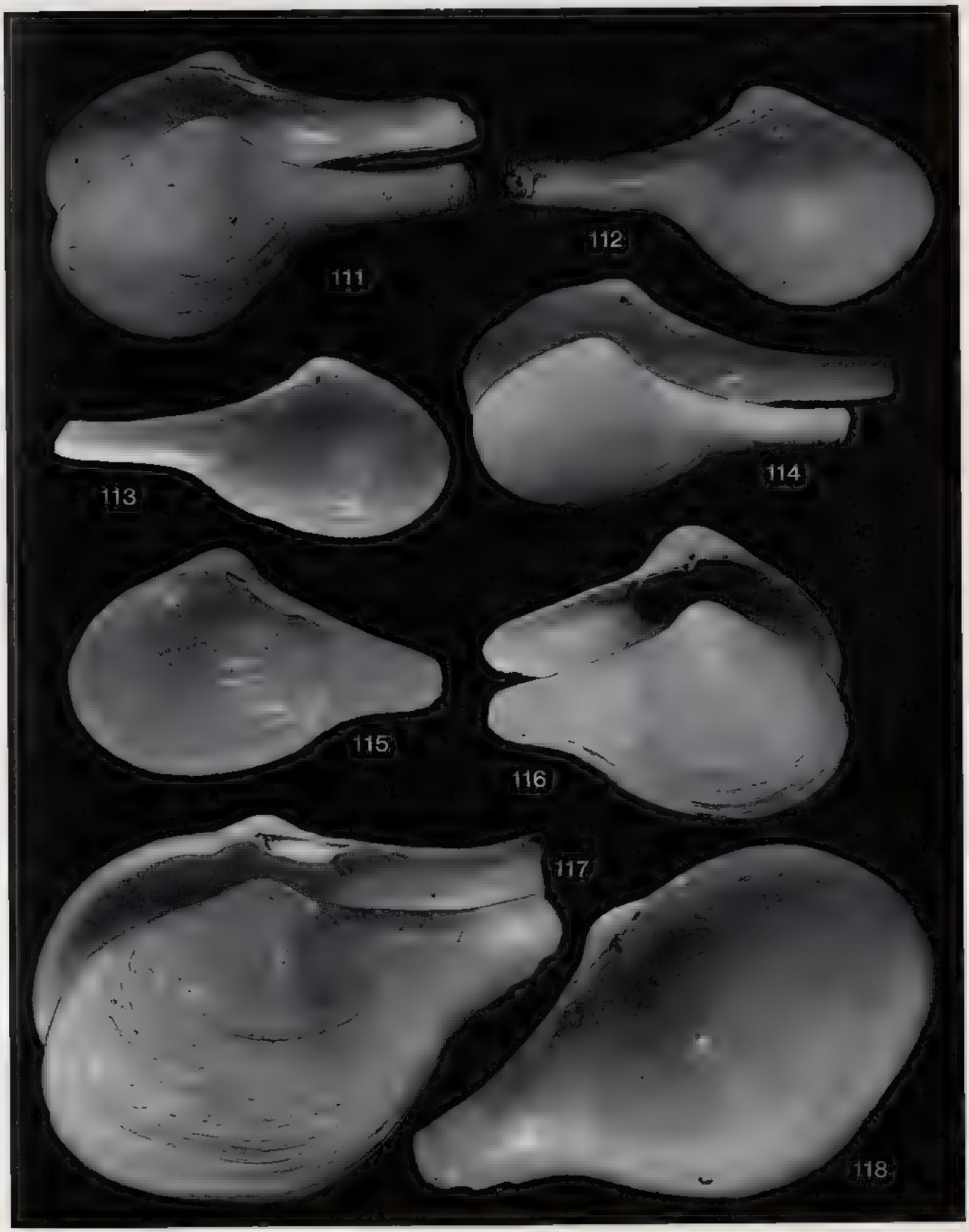
Material (948-1870 m). Balgim DW11: 2 specs. (jv)+3 v - CP62· 2 v - CP63 3v. CP91: 1 spec.+ 14v. - DW94: 1 spec. - CP95: 9v. - DW96: 11 v

Remarks: This species is quite similar to *C. teres* in size and shape, but is readily distinguished from it by the hinge. *C. inflata* lacks the well developed posterior lateral tooth in the right valve of *C. teres*, and has radial striae on the rostrum.

Cuspidaria circinata (Jeffreys, 1876) (figs. 125-126)
Neaera circinata Jeffreys, 1876 - Ann. Mag. nat Hist. (4)18· 497

Material (2035 m): Balgim CP68· 3 v.

Figures 111-112 *Cuspidaria wollastoni* (Smith, 1885), Balgim CP63, 1510 m Exterior of left valve and hinge line of right valve. Interior of left valve (24.2 mm).
Figures 113-114. *Cuspidaria rostrata* (Spengler, 1793). Interior of left valve, Balgim DR118, 352 m (13 8 mm). Exterior of left valve (DR118, same as fig 113) and hinge line of right valve, Balgim DR71, 155 m (14.7 mm).
Figures 115-116 *Cuspidaria cuspidata* (Olivi. 1792). Interior of right valve, Balgim CP119, 517 m (20 6 mm). Exterior of right valve (CP119, same as fig 115) and hinge line of left valve, Balgim DR70, 147 m (12.8 mm).
Figures 117-118. *Cuspidaria ventricosa* Verrill & Bush, 1898, Balgim CP10, 1592 m. Exterior of left valve and hinge line of right valve. Interior of left valve (19.8 mm)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Cuspidaria (Myonera) angularis (Jeffreys, 1876) (figs. 127-128)
Neaera angularis Jeffreys, 1876 - Ann. Mag. nat. Hist. (4)18: 498

Material (1250-1378 m): Balgim CP62. 1 v. - CP95: 1 v. - DW96: 15 v.

Cuspidaria (Tropidomya) abbreviata (Forbes, 1843) (figs. 129-130)
Nearea abbreviata Forbes, 1843 - Proc. Zool. Soc. London 11 (1843): 75

Material (181-555 m) Balgim DW20. 1 spec. (jv.) - DW27. 3 specs. (2 jv) - DW32 3 specs (jv) - CP33. 1 spec (jv.) - DR45 1 spec +4 specs +8 v. - DR73 1 spec - DW74 1 v - DW87 7 specs. (2 jv.) - DR118 2 v. - DW120· 1 spec (jv.) - DW128 1 v - DW146 13 specs (jv) - DR147 2 specs (jv.) - CP149 1 spec - Fauna 1 14A 1 v

Cuspidaria truncata (Jeffreys, 1882) (figs. 131-132)
Neaera truncata Jeffreys, 1882 - Proc. Zool Soc. London (1881): 936, pl 70 fig. 9

Material (740-948 m)· DW88: 1 spec. - CP90. 1 spec. - CP91: 1 spec

Cuspidaria (Cardiomya) striata (Jeffreys, 1876) (figs. 133-134)
Neaera striata Jeffreys, 1876 - Ann. Mag. nat Hist. (4)18· 495

Material (890-1592 m)· Balgim CP10 1 spec +7 v - CP18 1 spec. - DW88. 1 v - CP89 4 v - CP90 1 spec - CP91: 1 spec.+12 v. - CP92: 1 v.

Cuspidaria (Cardiomya) curta (Jeffreys, 1876) (figs. 135-136)
Neaera curta Jeffreys, 1876 - Ann. Mag. nat. Hist. (4)18: 495

Material (948-1141 m) Balgim DR06 1 v - DW07. 1 spec - DR45. 1 spec - CP91 2 spec +1 v - CP160· 1 v. - Fauna 1 76A: 1 v

Cuspidaria (Cardiomya) costellata (Deshayes, 1835) (figs. 137-138)
Corbula costellata Deshayes, 1835 - Exp. Sc. Morée (Moll.): 86, pl. 24 fig. 1-4

Material (147-681 m) Balgim CP03 1 spec (jv) - DR06 1 v. - DW20: 5 specs. (jv) - DR22 3 specs +1 v - DR23 2 specs. - DR45: 3 specs.+ 38 v - DW47: 1 spec. (jv) - DW53· 1 spec (jv) - DR70 1 spec (jv) - DR71: 1 spec + 4 v. - DR72: 3 v - DW74. 5 specs. (3 jv)+2 specs (jv.) - DR75. 1 spec. - DR79. 4 specs. - DR81: 13 specs (1 jv.) - DR82· 45 specs +4 v. - DR85 1 spec - DW87: 1 spec - DR101: 1 spec. - DR115. 1 v - DR118 1 spec. - DW120· 4 specs +7 v. - DW126: 1 spec - DW128. 1 spec (jv) - DR133· 1 spec. + 1 v - CP135· 1 spec - DW136. 2 v - DW142 1 v - DW143 3 specs. (jv) - DW146 4 specs (jv) - DW147: 1 spec. (jv.) - Fauna 1 76A 1 spec.+3 v

Remarks: There is a trend for the specimens from shallower localities conform the morphology of typical *C. costellata*, whereas those from slightly deeper water tend to have more ribs and would conform *C. striolata* Locard, 1898. There is a gradual transition in some large samples (e.g. DR45), and I consider both taxa as synonyms.

Halonympha depressa (Jeffreys, 1882) (figs. 139-140)
Neaera depressa Jeffreys, 1882 - Proc. Zool Soc. London (1881): 940, pl. 71 fig 3

Material (1141-1378 m): Balgim DW07 1 spec. - DW61 6 specs - CP62 38 specs (5 jv) + 4 v - CP90· 1 spec. - CP92: 4 specs (1 jv.) - DW94: 7 specs. (2 jv.) - CP95· 1 spec. - DW96: 2 specs.

Protocuspidaria colpodes (Dautzenberg & Fischer, 1897) (figs. 123-124)
Cuspidaria colpodes Dautzenberg & Fischer, 1897 - Mém Soc. zool Fr 10: 223, pl. 7 fig 3-4

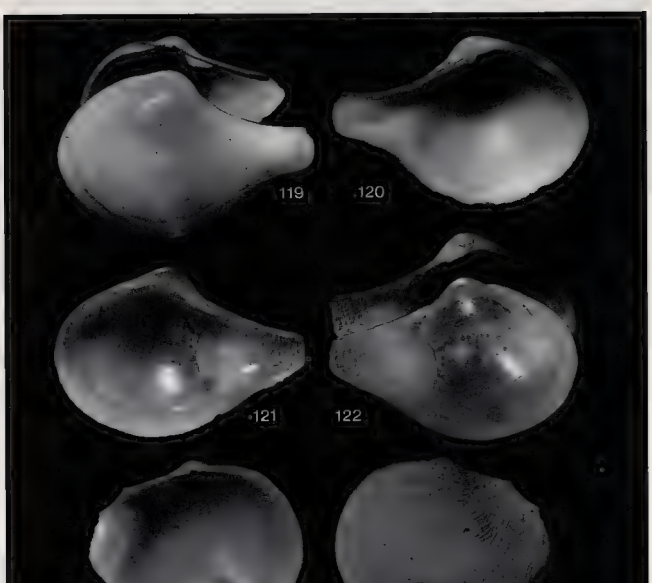
Material (1530-2035 m): DW64: 1 v. - CP68: 1 spec. (jv.)

Remarks: *Protocuspidaria verityi* Allen & Morgan, 1981 may be a synonym.

VERTICORDIIDAE

Verticordia acuticostata (Philippi, 1844) (figs. 141-143)
Hippagus acuticostatus Philippi, 1844 - En. Moll. Sic. II: 42, pl. 14 fig. 19a-c

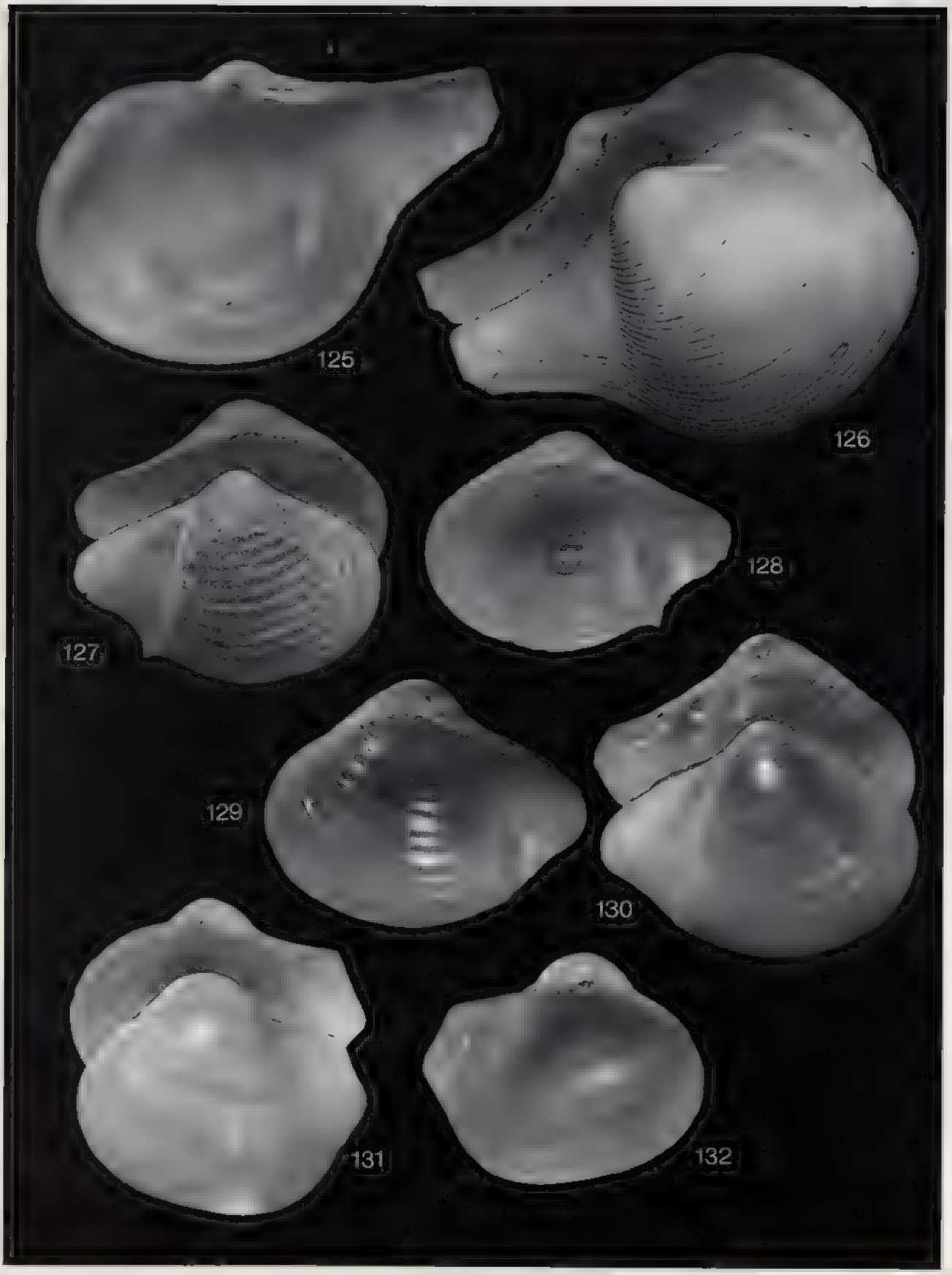
Material (466-1255 m). Balgim DR22: 1 v - DR56 2 v - CP62: 1 v. - CP91. 2 v. - CP92: 3 v - DW96: 1 v.



Figures 119-120. *Cuspidaria teres* (Jeffreys, 1882) Exterior of left valve, Balgim CP63, 1510 m (13.0 mm) and hinge line of right valve, Balgim DW96, 1255 m (8.0 mm). Interior of left valve (CP63, same as fig. 119).
Figures 121-122. *Cuspidaria inflata* (Jeffreys, 1882), Balgim CP63, 1510 m. Interior of right valve. Exterior of right valve and hinge line of left valve (7.6 mm).
Figures 123-124 *Protocuspidaria colpodes* (Dautzenberg & Fischer, 1897), Balgim DW64, 1530 m. Interior and exterior of left valve (7.5 mm).

Verticordia granulata Seguenza, 1860 (figs. 144-146)
Verticordia granulata Seguenza, 1860 - J. Conchyl. 8: 293-294, pl. 10 fig. 2 f-h

Material: (180-370 m): Balgim DW20: 1 v - CP21: 2 v. - DR22. 4 v - DW27: 1 spec. (jv.) - CP34: 1 spec. (jv.) - DR45: 2 v. - DR56: 3 v. - DR75: 1 spec. (jv.) - DR82: 2 specs. (1 jv.)+1 v. - DW128. 22 v.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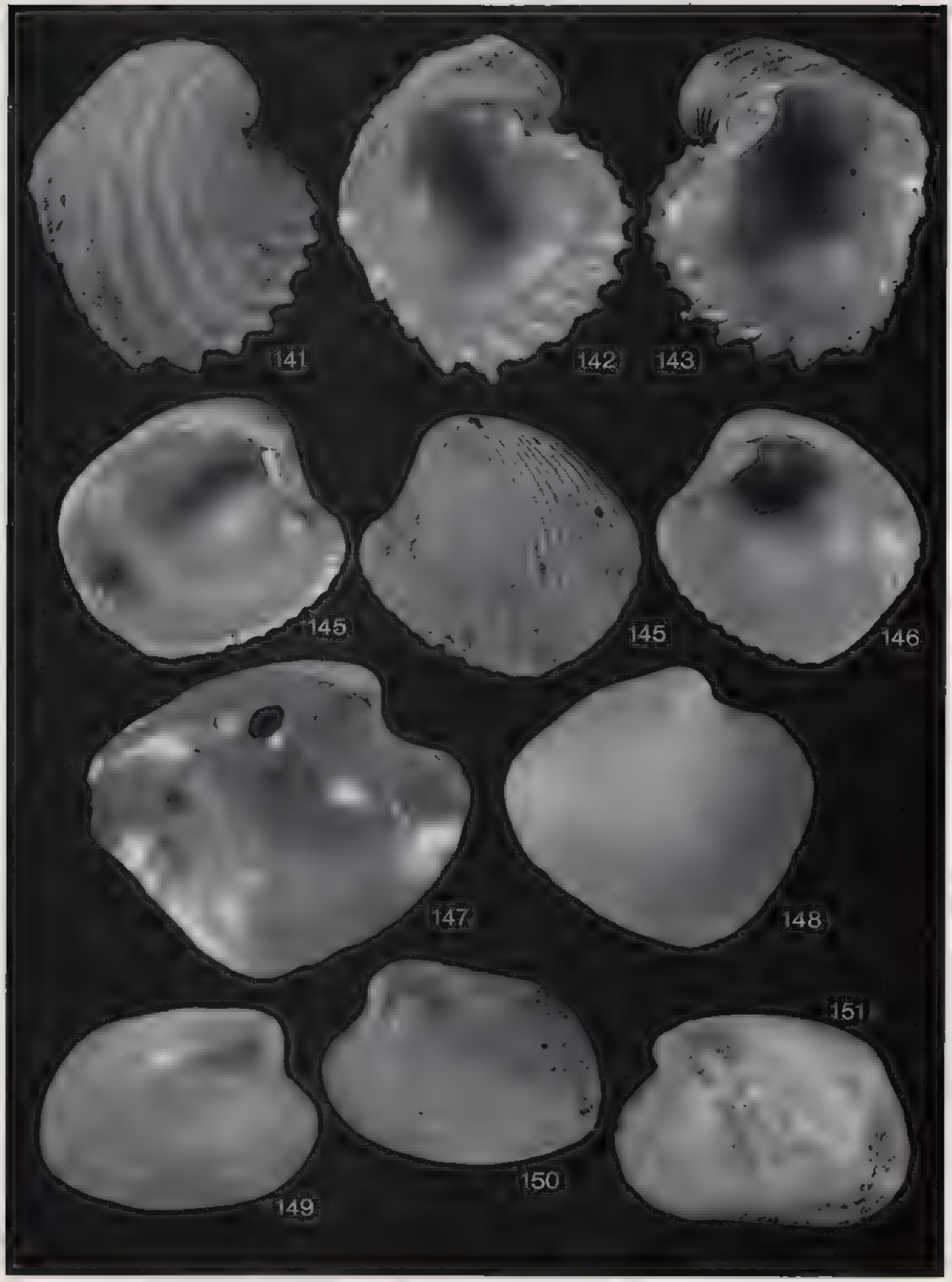
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Verticordia quadrata Smith, 1885 (figs. 147-148)
Verticordia quadrata Smith, 1885 - Challenger Rep. 13. 169, pl. 25 fig. 8,8b

Material: (252-740 m): Balgim : DW88: 1 spec.+1 v. - DW143: 5 specs. (jv)

Lyonsiella abyssicola (G. O. Sars, 1872) (fig. 151)
Pecchiolia abyssicola G. O. Sars, 1872 ex M. Sars ms. - On some remarkable forms of animal life from the great deeps off the Norwegian coast: 25, pl. 3 fig. 21-43.

Material (1523 m): Balgim DW11: 1 spec.

Lyonsiella subquadrata (Jeffreys, 1882) (figs. 149-150)
Pecchiolia subquadrata Jeffreys, 1882 - Proc. Zool Soc. London (1881). 932, pl. 70 fig 3

Material (948-2035 m): DW11· 1 spec. (jv.) - DW16: 6 specs (5 jv) - CP68. 4 specs. (1 jv.) - CP91: 7 specs - DW94· 4 specs. (3 jv.)

Polycordia gemma (Verrill, 1880) (figs. 109-110)
Lyonsiella gemma Verrill, 1880 - Proc. U. S. Nat. Mus. 3: 396

Material (489-1870 m): Balgim CP10: 1 v. - DW11· 1 v (jv) - DW88. 1 spec. (jv.) - CP90: 3 specs. (1 jv.) - DW94: 5 specs. (3 jv.) - DR118: 1 v. - DW147: 1 spec. (jv.)

Polycordia densicostata (Locard, 1898)
Verticordia densicostata Locard, 1898 - Exp. Trav. Talism. 2: 202-204, pl. 10 fig. 5-8

Material (2028 m): Balgim CP69· 1 v

Halicardia flexuosa (Verril & Smith, 1881)
Mytilimeria flexuosa Verrill & Smith, 1881 - Amer. J. Sc. (3) 22: 302

Material (1592 m): Balgim CP10: 1 spec

Figures 125-126. *Cuspidaria circinata* (Jeffreys, 1876), Balgim CP68, 2035 m. Interior of right valve Exterior of right valve and hinge line of left valve (16.9 mm)
Figures 127-128 *Cuspidaria (Myonera) angularis* (Jeffreys, 1876), Balgim DW96, 1255 m. Exterior of right valve (7.1 mm) and hinge line of a left valve (different specimen, 7 5 mm). Interior of right valve (same as figure 127).
Figures 129-130. *Cuspidaria (Tropidomya) abbreviata* (Forbes, 1843), Balgim DW87, 500 m. Interior of right valve. Exterior of right valve and hinge line of left valve (7.3 mm).
Figures 131-132 *Cuspidaria truncata* (Jeffreys, 1882), Balgim CP90, 890 m Exterior of left valve and hinge line of right valve. Interior of left valve (7.0 mm).

Figures 133-134. *Cuspidaria (Cardiomya) striata* (Jeffreys, 1876), Balgim CP91, 948 m Exterior of left valve and hinge line of right valve. Interior of left valve (11.1 mm).
Figures 135-136. *Cuspidaria (Cardiomya) curta* (Jeffreys, 1876), Balgim CP91, 948 m Interior of left valve. Exterior of left valve and hinge line of right valve (8.1 mm).
Figures 137-138. *Cuspidaria (Cardiomya) costellata* (Deshayes, 1835), Balgim DR71, 155 m. Exterior of right valve and hinge line of left valve. Interior of right valve (5 3 mm).
Figures 139-140. *Halonympha depressa* (Jeffreys, 1882), Balgim CP90, 890 m. Interior of left valve. Exterior of left valve and hinge line of right valve (5.0 mm)

Figures 141-143. *Verticordia acuticostata* (Philippi, 1844), Balgim DR56, 481 m. Exterior of right valve, interior of left valve and interior of right valve (12.5 mm)
Figures 144-146. *Verticordia granulata* Seguenza, 1860, Balgim DW128, 480 m. Interior and exterior of a left valve (10.5 mm) and interior of a right valve (9.9 mm).
Figures 147-148. *Verticordia quadrata* Smith, 1885, Balgim DW88, 740 m 147 Interior of a left valve, (6.4 mm). 148. Exterior of a right valve (3.8 mm).
Figures 149-150 *Lyonsiella subquadrata* (Jeffreys, 1881), Balgim DW16, 1283 m. Exterior of right valve (3.4 mm) and exterior of left valve (3.6 mm)
Figure 151. *Lyonsiella abyssicola* (G O Sars, 1872), Balgim DW11, 1523 m. Exterior of left valve (4 9 mm).

Station nº	F39	F22	F23	F33	F18	F4	F13	F38	F12	F5	F6	F17	F24	F42	F7	F37	F11	B130	B142	B132	B141	B133
Depth (m)	23	30	32	44	52	60	52	62	64	68	74	74	78	67	96	100	110	145	167	170	177	185
Nucula sulcata										2												
Nucula nitidosa *								3														
Nucula tumidula																						
Nucula decipiens																						
Ennucula bushae																						
Ennucula aegeensis																						
Nuculana commutata							2	6		1												
Yoldiella messanensis								1														
Yoldiella philippiana									1												1	1
Yoldiella semistriata																						
Barbatia scabra																						
Bathyarca philippiana																						
Bathyarca pectunculoides																						
Bentharca asperula																						
Anadara polii						3	3	11	1		2											
Limopsis aurita																			3		1	
Limopsis minuta																						
Limopsis cristata																						
Limopsis angusta																						
Modiolus phaseolina		17	10	10	5		63	18				20				34		2		1		
Amygdalum politum																						
Rhombodella prideauxi *				16																		
Modiolarca subpicta		1	3		1		4	33														
Gregariella semigranata		43	34	47	70		31	2		1		71				20						
Dacrydium cf. *hystrium*																						
Pteria hirundo							9	3				1										1
Neopycnodonte cochlear						20		1						2		23	2		1	1		
Aequipecten opercularis	1	14	2				2	17								6						
Chlamys multistriata *		3	6	7								1										
Chlamys bruei																						
Cyclopecten lenestratum																				1		
Similipecten similis								3											150	2	5	2
Delectopecten vitreus																						
Palliolum incomparabile *			1		1			2								1						
Propeamussium hyalinacas																						
Heteranomia squamula											4								2	1		
Diplodonta apicalis		2		1																		
Thyasira cf. *granulosa*																						
Thyasira flamgnea										6												
Thyasira sitteri																						
Thyasira subovata																						
Thyasira asmyrae																						
Thyasira croulinensis																						
Thyasira cf. *obsoleta* *																						
Kelliella subcorbuliens		20	4	13	10		35	4				11				2						
Mysella bidentata		1		8			7	10														
Cardita calyculata *			1	151				1				1										
Glans scobella						1																
Astarte sulcata																1			1			
Digitaria digitaria *			1					1										1				
Parvicardium hoskynn *		21	4	1															1			
Parvicardium minimum								1			1								1			
Laevicardium crassum		2						8								1		1				
Talina compressa *								8		2			3									
Abra longicallus																						
Ervilia castanea				33																		
Kellella abyssicola																						
Venus nux *						2			6	88						2		1				
Globivenus effossa *																				1		
Chamelea striatula *								1	16	18			1				1					
Gouldia minima *		5	4	2																		
Timoclea ovata	11	24	1			4	1	60		3	1		1	2				6	4		6	2
Clausinella fasciata *		9	1					1														
Tapes rhomboides *		18	3				1	5														
Corbula gibba	1							114			2											
Gastrochaena dubia *		1		1								1										
Hiatella arctica		18	22	20	13		160	116			1	26				88						
Cochlodesma tenerum																						
Allogramma formosa																						
Cuspidaria cuspidata																						
Cuspidaria rostrata																						1
Cuspidaria abbreviata																						
Cuspidaria costellata																						1
Halonympha depressa																						
Lyonsiella subquadrata																						
Verticordia quadrata *																						
Polycordia gemma *																						

Table 1. Bathymetric range of selected Bivalve species in the Alboran Sea, and numbers of live-taken specimens. Asterisks denote the species which are not plotted for every transect (B numbers. Balgim, F numbers· Fauna 1).

B134	B143	F14	B136	F15	F28	B144	B118	B145	B149	B135	B120	B128	B147	B148	B119	B146	B121	B127	B126	B137	B123	Station n°
205	252	290	298	306	308	328	352	386	390	400 C	425	480	492	503	551	565	582	720	998	1005	1238	Depth (m)
		10					1		3	12	48	3	3		1	2						*Nucula sulcata*
																						Nucula nitidosa *
																						Nucula tumidula
						6		7														*Nucula decipiens*
																						Ennucula bushae
							1	4		26	40	10	5			3	3	6	6	14		*Ennucula aegaensis*
	14					6	1	1			1											*Nuculana commutata*
												1				3						*Yoldiella messanensis*
	19	1	3			17		1	1	4	36		3			110		1				*Yoldiella philippiana*
																						Yoldiella semistriata
																						Barbatia scabra
										2		7										*Bathyarca philippiana*
	1			1												2						*Bathyarca pectunculoides*
																						Bentharca asperula
																						Anadara polii
												4										*Limopsis aurita*
																						Limopsis minuta
																						Limopsis cristata
										28												*Limopsis angusta*
1						1					1											*Modiolula phaseolina*
														1				2				*Amygdalum politum*
																						Rhomboidella prideauxi *
																						Modiolarca subpicta
		1																				*Gregariella semigranata*
										4												*Dacrydium cf. hyalinum*
																						Pteria hirundo
																						Neopycnodonte cochlear
																						Aequipecten opercularis
																						Chlamys multistriata *
										6												*Chlamys bruei*
			2													1						*Cyclopecten fenestratum*
22	2		2																			*Similipecten similis*
										2		1						1				*Delectopecten vitreus*
																						Palliolum incomparabile *
																						Propeamussium hypomecs
								1		6		1										*Heteranomia squamula*
																						Diplodonta apicalis
										1		1										*Thyasira cf. granulosa*
		1		1						6	20		15									*Thyasira ferruginea*
	4																					*Thyasira alleni*
	2										38	48	4									*Thyasira subovata*
											1		1						7	5	3	*Thyasira sumyaria*
											9	5	17						3			*Thyasira croulinensis*
10							1				172		26				2					*Thyasira cf. obsoleta* *
		1																				*Kellia suborbicularis*
																						Mysella bidentata
																						Cardita calyculata *
																						Glans aculeata
																						Astarte sulcata
6																						*Digitaria digitaria* *
		1																				*Parvicardium nodosum* *
2	30						1		1		4				3	9						*Parvicardium minimum*
																						Laevicardium crassum
		2		1	3		6	6	33	28	62	16	2	3	10	10	3	29	3	1	1	*Tellina compressa* *
																						Abra longicallus
1	9	6		3			3				85	41	3			12	2		1			*Ervilia castanea*
																						Kellielia abyssicola
																						Venus nux *
																						Globivenus effossa *
																						Chamelea striatula *
																						Gouldia minima *
5	24															4						*Timoclea ovata*
																						Clausinella fasciata *
																						Tapes rhomboides *
																						Corbula gibba
																						Gastrochaena dubia *
										9										7		*Hiatella arctica*
																		2				*Cochlodesma tenerum*
																						Allogramma formosa
8	1						1															*Cuspidaria cuspidata*
			1		1				2	1	1	2				2		1	1	1		*Cuspidaria rostrata*
									1		1		2			13						*Cuspidaria abbreviata*
	3						1			1	4	1	1			4			1			*Cuspidaria costellata*
																						Halonympha depressa
																						Lyonsiella subquadrata
	5																					*Verticordia quadrata* *
													1									*Polycordia gemma* *

Table 1 (continued).

Station	F60	F56	F58	F55	F61	F57	F3	B151	B42	B113	B43	B114	B47	B45	B40	B51
Depth (m)	16	24	34	42	44	80	116	120	137	144	150	158	281	293	362	362
Nucula sulcata							1									
Nucula nitidosa *																
Nucula tumidula																
Nucula decipiens																
Ennucula bushae																
Ennucula aegeensis																
Nuculana commutata													2	41		
Yoldiella messanensis																
Yoldiella sublaevis *																
Yoldiella insculpta *																
Yoldiella jefreysi *																
Yoldiella philippiana													1	3		
Yoldiella semistriata																
Barbatia scabra									2							
Bathyarca philippiana									1		2				3	
Bathyarca pectunculoides							15						3			
Bentharca asperula																
Anadara polii				1		27	11									
Limopsis aurita																
Limopsis minuta																
Limopsis cristata																
Limopsis angusta																
Modiolula phaseolina		9	2		7	27				6	7					
Amygdalum politum																
Modiolarca subpicta	3	6			3					1						
Gregariella semigranata	4	10	10		18	14				1						
Dacrydium cf. hyalinum						1										
Pteria hirundo									3	15		6				
Neopycnodonte cochlear							9			2						
Aequipecten opercularis		1	1	6		26										
Chlamys multistriata *		1	1	1		3	5									
Chlamys bruei																
Cyclopecten fenestratum									2	4	1		1			
Similipecten similis						1			8							
Delectopecten vitreus																
Propeamussium hyponecos																
Anomia ephippium	2	3	2	8		1										
Heteranomia squamula								1		3	2					
Diplodonta apicalis									20		3					
Thyasira cf. granulosa														1		
Thyasira ferruginea																
Thyasira albini																
Thyasira subovata																
Thyasira sumyana																
Thyasira croulinensis																
Kellia suborbicularis	1	17	2		8	2										
Mysella bidentata	5	3	6		5	1										
Cardita calyculata *																
Glans aculeata			1			2			5		11			1		
Astarte sulcata						1			3		11			1		
Digitaria digitaria *	40				3							1				
Acanthocardia paucicostata *																
Parvicardium nodosum *	8		1				1									
Parvicardium minimum																
Laevicardium crassum *	2					4						1				
Abra longicallus														1		2
Ervilia castanea	108	2														
Kelliella abyssicola							3						9			
Venus nux *							1									
Chamelea striatula *	2															
Gouldia minima *			1			1			1	1						
Timoclea ovata	3					2	3		2	10	7	3				
Clausinella fasciata *			1													
Tapes rhomboides *	13	2	21		5	1										
Corbula gibba																
Gastrochaena dubia *			2	3		1										
Hiatella arctica	3	18	16		41	29	6	1	2	19						
Allogramma formosa																
Cuspidaria cuspidata																
Cuspidaria rostrata																
Cuspidaria wollastoni *																
Cuspidaria inflata *																
Cuspidaria abbreviata													4	9		
Cuspidaria costellata													1	3		
Cuspidaria curta *														6		
Halonympha depressa																
Lyonsiella subquadrata																

Table 2. Bathymetric range of selected Bivalve species in the axis of the straits of Gibraltar, and numbers of live specimens. Shaded bars underline approximate upper and lower limits of the Mediterranean water outflow.

B53	B56	B49	B50	B57	B152	B153	B58	B61	B62	B64	B63	B65	B68	B69	B66	Station
364	488	524	526	548	560 C	604 C	826	1222	1302	1530	1635	1805	2077	2077	2142	Depth (m)
																Nucula sulcata
																Nucula nitidosa *
																Nucula tumidula
																Nucula decipiens
							2	4	3	18	1		2			*Ennucula bushae*
	4															*Ennucula aegaensis*
																Nuculana commutata
				1						2	21	2				*Yoldiella messanensis*
													1			*Yoldiella sublaevis* *
													4			*Yoldiella insculpta* *
													2			*Yoldiella jefreysi* *
																Yoldiella philippiana
																Yoldiella semistriata
			4		1											*Barbatia scabra*
		1	4													*Bathyarca philippiana*
																Bathyarca pectunculoides
													6	1	1	*Bentharca asperula*
																Anadara polii
																Limopsis aurita
								10	89	3	31					*Limopsis minuta*
							1	2	23	1	1					*Limopsis cristata*
		1			1	24										*Limopsis angusta*
		1	2													*Modiolula phaseolina*
																Amygdalum politum
																Modiolarca subpicta
																Gregariella semigranata
		1	1			4			10		10					*Dacrydium cf. hyalinum*
																Plana hirundo
																Neopycnodonte cochlear
																Aequipecten opercularis
																Chlamys multistriata *
		2														*Chlamys brusi*
																Cyclopecten fenestratum
																Similipecten similis
									3		1					*Delectopecten vitreus*
									4		1					*Propeamussium hypomaces*
																Anomia ephippium
		10	20													*Heteranomia squamula*
																Diplodonta apicalis
1	1							2								*Thyasira cf. granulosa*
																Thyasira ferruginea
																Thyasira alleni
																Thyasira subovata
																Thyasira eumyaria
2																*Thyasira croulinensis*
																Kelliа suborbicularis
																Mysella bidentata
																Cardita calyculata *
																Glans aculeata
																Astarte sulcata
																Digitaria digitaria *
																Acanthocardia paucicostata *
																Parvicardium nodosum *
																Parvicardium minimum
																Laevicardium crassum *
31	7								1							*Abra longicallus*
																Ervilia castanea
7								2								*Kelliella abyssicola*
																Venus nux *
																Chamelea striatula *
																Gouldia minima *
																Timoclea ovata
																Clausinella fasciata *
																Tapes rhomboides *
																Corbula gibba
																Gastrochaena dubia *
			2													*Hiatella arctica*
																Allogramma formosa
2																*Cuspidaria cuspidata*
																Cuspidaria rostrata
											1					*Cuspidaria wollastoni* *
									5							*Cuspidaria inflata* *
																Cuspidaria abbreviata
1																*Cuspidaria costellata*
																Cuspidaria curta *
								8	44							*Halonympha depressa*
													4			*Lyonsiella subquadrata*

Table 2 (continued).

Station nº	F71	F45	F70	F43	F52	F44	F51	F66	F67	F69	F50	B34	F1	F49	B32	B33	F46	B27	B26
Depth (m)	15	19	22	24	24	26	28	28	56	112	122	182	190	240	250	256	366	371	403
Nucula sulcata									1	6	1	43	4	1	4	9	1	2	2
Nucula nitidosa *	645					15		21											
Nucula lumbulis																			
Nucula decipiens																			
Ennucula bushiae																			
Ennucula aegaisnes															14	5		7	6
Nuculana commutata		1								1		32	2		77	21		149	14
Yoldiella messanensis																			
Yoldiella philippiana																			
Yoldiella inculpta *																			
Yoldiella semistriata																			
Bathyarca scabra																			
Bathyarca philippiana																			
Bathyarca pectunculoides																			1
Bentharca asperula																			
Anadara polii			1								1	2	6	4					
Limopsis aurita																			
Limopsis minuta																			
Limopsis cristata																			
Limopsis anguila																			
Modiolula phaseolina					2		2	1											
Amygdalum pahtum																			
Modiolarca subpicta			6		1														
Gregariella semigranata			6		1		28	1											
Dacrydium cf. hyalinum																			
Pteria hirundo												3							
Neopycnodonte cochlear					3														
Aequipecten opercularis						1													
Chlamys multistriata *			1				8												
Crassmys bruei																			
Cyclopecten fenestratum																			
Cyclopecten hoskynsi *																			
Similpecten similis																			
Delectopecten vitreus																			
Propeamussium hyomesces																			
Anomia ephippium	1		6		1	4													
Heteranomia squamula		1													1				
Diplodonta apicalis																			
Thyasira cf. granulosa												9			8	3			13
Thyasira ferruginea																		6	
Thyasira allani												4			12			88	122
Thyasira subovata															6			1	1
Thyasira euxinyana																			1
Thyasira croahnensis																			
Thyasira cf. obsoleta *																2			
Kellia suborbicularis			21				2												
Mysella bidentata	11		5			1													
Cardita calyculata *						17													
Glans aculeata																			
Astarte sulcata																			
Digitaria digitaria *			45			37	3												
Acanthocardia peucocostata	10		3			10		1							1				
Parvicardium hodosum *			2																
Parvicardium minimum															1			1	
Laevicardium crassum *			16			1													
Abra longicallus												2			5	10		3	6
Erycina castanea																			
Kellella abyssicola												2	1		149	3		65	66
Venus nux *							4		5	3	4	10	1	2			4		
Chamelea striatula *	259	3	1			7		22	1	2									
Glaucilla marma *			30																
Timoclea ovata												8			3				
Clausinella fasciata *			3					1											
Tapes rhomboides *		1	2			1													
Corbula gibba	81	4	24		3	169	2	88		13		1			4				
Gastrochaena dubia *			2	4				1											
Hiatella arctica		1	35		6	5	15	5											
Lyonsia norwegica *	4		2																
Allogramme hirmosa																			
Poromya granulata *																			
Cuspidaria cuspidata												7			1	7		1	
Cuspidaria rostrata												1							
Cuspidaria abbreviata												5			3	1		3	
Cuspidaria costellata																			
Halonympha depressa																			
Lyonsiella subpostata																			
Verticordia granulata *												1						1	

Table 3. Bathymetric range of selected Bivalve species off Huelva, Southwestern Iberian Peninsula, and numbers of live-taken specimens. Shaded bars underline approximate upper and lower limits of the Mediterranean water outflow.

B20	F72	B22	B21	B25	B24	F76	B23	B155	B157	B109	B160	B159	B108	B107	Station n°
454	468	472	491	544	546	548	556	903	1108	1216	1362	1370	1534	1926	Depth (m
															Nucula sulcata
															Nucula nucleus *
													2		*Nucula tumidula*
					1		3								*Nucula decipiens*
														12	*Ennucula bushae*
		1				2				1					*Ennucula aegeensis*
				1											*Nuculana commutata*
2		12			5	37			1		1				*Yoldiella massanensis*
				1						11					*Yoldiella philippiana*
														1	*Yoldiella inscripta* *
		1								2	5	6			*Yoldiella semusinata*
2															*Barbatia scabra*
4		10	33	10		6									*Bathyarca philippiana*
4				4		4						1	2		*Bathyarca pectunculoides*
															Benthoarca asperula
															Anadara polii
3		1				1									*Limopsis aurita*
2		9		1					1				24		*Limopsis minuta*
													15		*Limopsis cristata*
															Limopsis anguste
															Modiolula phaseolina
															Amygdalum politum
															Modiolarca subpicta
															Gregariella semigranata
													2		*Dacrydium cf. hyalinum*
															Pteria hirundo
															Neopycnodonte cochlear
															Aequipecten opercularis
															Chlamys multistriata *
															Chlamys bruei
3															*Cyclopecten fenestratum*
				1		2									*Cyclopecten hoskynsi* *
14		1		3	2										*Similipecten similis*
													3		*Dyscritopecten vitreus*
															Propeamussium hyalinum
															Anomia ephippium
				4				3							*Heteranomia squamula*
															Diplodonta apicalis
				2	5		4	1							*Thyasira cf. granulosa*
								1			1	1			*Thyasira ferruginea*
				1	1										*Thyasira alleni*
															Thyasira subcrata
								1				13			*Thyasira eumyaria*
												3			*Thyasira croulinensis*
															Thyasira cf. obsoleta *
															Kellia suborbicularis
						1									*Mysella bidentata*
															Cardiia calyculata *
															Glans soluta
						1									*Asterla sulcata*
															Digitaria digitaria *
															Acanthocardia pseudaculeata
															Parvicardium exiguum *
						1									*Parvicardium minimum*
															Laevicardium crassum *
		6		2		2	1			1	7	2			*Acta longicallus*
															Ervilia castanea
119					17	22									*Kellielia abyssicola*
															Venus nux *
															Chamelea striatula *
															Gouldia minima *
															Timoclea ovata
															Clausinella fasciata *
															Tapes rhomboides *
															Corbula gibba
															Gastrochaena dubia *
															Hiatella arctica
															Lyonsia norwegica *
															Allogramma formosa
			1												*Periploma granulata* *
															Cuspidaria cuspidata
		2													*Cuspidaria rostrata*
1															*Cuspidaria abbreviata*
5		3				1	2								*Cuspidaria costellata*
															Heteromyrtea depressa
									1			1			*Lyonsiella subquadrata*
															Verticordia granulata *

Table 3 (continued).

Station nº	B70	B71	B72	B73	B74	B75	B79	B81	B103	B101	B82	B85	B87	B86	B89	B88	B90	B91	B94	B92	B96	B95	B98	B99
Depth (m)	147	155	173	181	181	252	267	305	347	353	355	497	500	518	724	742	895	948	1178	1182	1235	1378	1773	1848
Nuculs sulcata	1		1								1													
Nucula tumidula																					2			
Nucula decipiens																								
Nucula staudtana *																						1		
Ennucula bushae															8	30	36			1				1
Ennucula aegaeensis		1								1														
Microgloma pusilla *																9								
*Microgloma tumidula**															2									
Nuculana commutata	1		1		2						1		1											
Yoldiella messanensis									1							1				1	1	13		
Yoldiella philippiana							2	3	5		10													
Yoldiella insculpta *																							1	
Yoldiella semistriata												1	3		1	2								
Yoldiella sequenzae *																								
Nielsenella stroeta *																								
Malletia cumeta *																		1						
Malletia johnsoni *																								
Barbatia scabra																								
Bathyarca philippiana							1	7			7													
Bathyarca pectunculoides						6		13			47							1			1			
Bentharca asperula																								
Arcadia pelt																								
Limopsis aurita											1													
Limopsis minuta								1							2	1	32	5		3	13	58		
Limopsis cristata																2	5				3	1		
Limopsis anguia																								
Modiolula phaseolina																								
Amygdalum politum															5		1							
Modiolarca subpicta																								
Gregariella semigranata																								
Dacrydium cf. hyalinum																1			1	12	1	12		
Plaia hirundo						1				1														
Neopycnodonte cochlear																								
Aequipecten opercularis																								
Chlamys bruei																								
Cyclopecten hoskynsi *							1																	
Cyclopecten farsetratum																								
Similpecten similis						1																		
Delectopecten vitreus															1		9	21		7				
Propeamussium hyalinum																	2	1	2		3	1		
Anomia ephippium																								
Heteranomia squamula																								
Dimodonta spcass																								
Thyasira cf. granulosa					1									3					2	1				
Thyasira ferruginea																								
Thyasira eleni	2		1					1		13														
Thyasira subovalis		1																						
Thyasira sumyra																								
Thyasira croulinensis																								
Thyasira cf. obsoleta *		4														6								
Kelia subornbuiaris																								
Myselia bilateiata																								
Gians acuiaata																								
Asteria sulcata																								
Ravicendrum mmmum																								
Abra longicallus		1	2		5	2	2	2		8		2	21	4	3	7	6	12						
Ervilia castanea																								
Kellella abyssicola		4	1		1											5								
Tenoclea ovata					3																			
Corbula gibba																								
Hiatella arctica	1																							
Allogramma formosa													1	1	1	1				2				
Poromya granulata *		1									2													
Cuspidaria cuspidata							1				1													
Cuspidaria rostrata			1		4			3			2				1	1								
Cuspidaria wollastoni *																								
Cuspidaria striata *															1		1	1						
Cuspidaria inflata *																		1	1		1			1
Cuspidaria abbreviata				1		1		2		1	3	14	14											
Cuspidaria truncata *																	1	1	1					
Cuspidaria cuna *																			1					
Cuspidaria costellata	1	1			5	1	4	13		1	45	1	1											
Halonymphe depressa																			7	4	2	1		
Verticordia quadrata																1								
Verticordia granulata						1					2													
Polycordia gemma *																1	3		7					1
Lyonsiella subquadrata																	2	11	4					

Table 4 Bathymetric range of selected Bivalve species off Northwestern Morocco and numbers of live specimens.

Station n°	B3	B1	B2	B6	B7	B9	B16	B17	B11	B10	B18
Depth (m)	664	721	925	1114	1144	1192	1265	1505	1540	1602	1612
Nucula sulcata											
Nucula tumidula									3		
Nucula decipiens											
Nucula atacellana °											
Ennucula bushae					2		7		6		
Ennucula aegeensis	2	3	42		9						
Microgloma pusilla °			1						14		
Microgloma tumidula °			2				8		35		
Nuculana commutata											
Yoldiella messanensis			1								
Yoldiella philippiana											
Yoldiella insculpta °											
Yoldiella semistriata											
Yoldiella seguenzae °				1					1		
Nellonella stnolata °					1				1		
Malletia cuneata °									3		
Malletia johnsoni °											2
Berbatia scabra											
Bathyarca philippiana											
Bathyarca pectunculoides					2		1				
Bentharca asperula											
Anadara poli											
Limopsis aurita											
Limopsis minuta											
Limopsis cristata									4		
Limopsis angusta											
Modiolula phaseolina											
Amygdalum politum											
Modiolarca subpicta											
Gregariella semigranata											
Dacrydium cf. hyalinum											
Pteria hirundo											
Neopycnodonte cochlear											
Aequipecten opercularis											
Chlamys bruei											
Cyclopecten hoskynsi °											
Cyclopecten fenestratum											
Similipecten similis											
Delectopecten vitreus							1	1			
Propeamussium hypomecos									1		
Anomia ephippium											
Heteranomia squamula											
Diplodonta apicalis											
Thyasira cf. granulosa	1		1		5		11		3		
Thyasira ferruginea			1								
Thyasira alleni											
Thyasira subovata											
Thyasira aumyana					1		8		1		
Thyasira croulinensis			10								
Thyasira cf. obsoleta					8						
Kelia suborbicularis											
Myselia bidentata											
Glans aculeata											
Astarte sulcata											
Parvicardium minimum											
Abra longicallus			4	1	13	7	13	3			
Ervilia castanea											
Kelliella abyssicola			9		20		3		1		
Timoclea ovata											
Corbula gibba											
Hiatella arctica											
Allogramma formosa					1						
Poromya granulata °											
Cuspidaria cuspidata											
Cuspidaria rostrata						5					
Cuspidaria wollastoni °											2
Cuspidaria striata °										1	1
Cuspidaria inflata °									2		
Cuspidaria abbreviata											
Cuspidaria truncata °											
Cuspidaria curta °					1						
Cuspidaria costellata	1										
Halonympha depressa					1						
Verticordia quadrata											
Verticordia granulata											
Polycordia gemma °											
Lyonsiella subquadrata							6		1		

Table 5. Bathymetric range of selected Bivalve species in the axis off Cape St. Vincent, Portugal and numbers of live specimens. Shaded bars underline approximate upper and lower limits of the Mediterranean water outflow.

BATHYMETRIC AND GEOGRAPHIC DISTRIBUTION OF THE SPECIES

The bathymetric distribution of the species has been plotted separately for the Alboran Sea (table 1), the Atlantic in the axis of the strait of Gibraltar (table 2), two transects on the Northern side of the Ibero-Moroccan Gulf (tables 3 and 5) and one radial off Morocco (table 4). Species denoted by a * in the tables are not found in all transects and thus are plotted only where relevant.

In the Alboran Sea, there is a major faunal turnover around 250 m depth. The shallow part shows a high species richness of the shelf fauna, which may represent a variety of biocenoses. The most persistently occurring species in this material are *Nuculana commutata, Striarca lactea, Anadara polii, Modiolula phaseolina, Gregariella semigranata, Aequipecten opercularis, Kellya suborbicularis, Hiatella arctica*. On the outermost part of the shelf (150-250 m), the assemblage is dominated by *Similipecten similis* and *Timoclea ovata*.

The slope assemblage between 300 and 1000 m includes *Nucula sulcata, Ennucula aegeensis, Yoldiella philippiana, Thyasira* spp., *Parvicardium minimum, Kelliella abyssicola, Abra longicallus, Cuspidaria rostrata, C. abbreviata, C. costellata*. The 400-500 m interval has a particularly high representation of *Thyasira ferruginea, T. croulinensis T.* cf. *obsoleta, T. subovata*, and of *Kelliella miliaris* and *Abra longicallus*. Where hard bottoms with corals are represented, *Limopsis angusta* and *Bathyarca* spp. are represented (e. g. DR135, DR153). Apart from this, there is no major discontinuity in the distribution of bivalves along the slope. The fauna becomes scarce below 1000 m with hardly more than one living specimen per haul, and the deepest samples at 1433 (DW139) and 1742 m (DW140) were barren.

In the axis of the strait of Gibraltar, there is again a turnover between shelf samples (down to 158 m) and slope samples (from 281 m down). The shallow communities are quite similar to those in the Alboran Sea, with *Anadara polii, Striarca lactea, Modiolula phaseolina, Gregariella subclavata, Aequipecten opercularis* and other pectinids, *Kellya suborbicularis, Tapes rhomboides* and *Hiatella arctica* as the common species. The deepest part of the shelf features high occurrences of *Timoclea ovata* as in the Alboran Sea, but here *Similipecten similis* is not so abundant and is replaced by *Cyclopecten fenestratum*.

The distribution of bivalves on the slope is clearly twofold. The 280 m - 550 m depth interval, in contact with the Mediterranean water outflow, has an extremely poor fauna, with low numbers of bivalve species *Ennucula aegeensis, Nuculana commutata, Yoldiella philippiana, Modiolula phaseolina, Thyasira granulosa, Kellyella abyssicola, Abra longicallus, Cuspidaria abbreviata, C. costellata, C. curta*. The presence of hard bottoms induces the occurence of epifaunal species such as *Chlamys bruei, Heteranomia squamula, Limopsis angusta* and *Bathyarca* spp. In general, this is an impoverished image of the Alboran Sea slope fauna.

There is an important turnover on the slope below 826 m, with many additional species found. The change may appear sharper as an artifact due to the gap of sampling between 604 and 826 m. The characteristic species are *Ennucula bushae, Yoldiella messanensis, Limopsis minuta, L. cristata, Dacrydium* cf. *hyalinum, Delectopecten vitreus, Propeamussium hypomeces, Abra profundorum, Lyonsiella abyssicola, Halonympha depressa, Cuspidaria* spp. This is a classical North Atlantic slope fauna, in which the Eulamellibranchs are obviously underrepresented. Most of these species were not found at all in the Alboran Sea at any depth, the only exception being *Yoldiella messanensis*.

Along the radial of Huelva, on the northern side of the Ibero-Moroccan Gulf, the shift from shelf to slope fauna is not straightforward. The littoral species shared with Alboran and the strait (*Striarca lactea, Modiolula phaseolina, Gregariella semigranata, Anomia ephippium, Digitaria digitaria, Hiatella arctica*) are restricted to the upper 30 m or so, and are found together with a variety of endofaunal bivalves (*Nucula nitidosa, Acanthocardia* spp., *Chamelea striatula.* .). The outer part of the shelf (112-250 m) features a number of species which were found exclusively on the

slope in the Alboran Sea: *Nucula sulcata, Ennucula aegeensis, Nuculana commutata, Kelliella miliaris, Cuspidaria abbreviata,* together with shelf species which prefer muddy bottoms (*Anadara polii, Venus nux).*

The slope itself shows a very sharp turnover between 1370 and 1534 m, which coincides with the lower limit of the Mediterranean water outflow. The fauna down to 1370 m is quite impoverished, with main species shared with the Alboran slope and the 250-548 m interval of the strait: *Ennucula aegeensis, Yoldiella messanensis, Y. philippiana, Bathyarca philippiana, B. pectunculoides, Similipecten similis, Thyasira* spp., *Kellyella abyssicola, Abra longicallus, Cuspidaria costellata.*

The influx of deep-water Atlantic species is seen at 1570 m and below, with the occurrence of *Nucula tumidula, Ennucula bushae, Yoldiella insculpta, Limopsis minuta, L. cristata, Dacrydium* cf. *hyalinum, Delectopecten vitreum.* All those species find a barrier at the lower limit of the Mediterranean water. The only exception is an occurrence of *Limopsis minuta* at 454-472 m (DW20, DW22), consistent with the observation by physical oceanographers that the Mediterranean outflow divides in two separate layers around this depth. The bimodal distribution of the *Thyasira,* which here rather follow Mediterranean water, can be interpreted in the same manner.

The transect off Cape St. Vincent, Portugal, has only been sampled in the deepest part. The incidence of Mediterranean water on the fauna is too attenuated to form a real barrier, and this is reflected by a continuum of species across the supposed interval of Mediterranean water (1190-1300 m).

In the transect off Morocco, the absence of a Mediterranean outflow lets the Atlantic deep-water fauna occupy its natural bathymetric range. A progressive turnover is seen around 700 m. The upper part of the slope contains *N. sulcata, Ennucula aegeensis, Nuculana commutata, Yoldiella philippiana, Bathyarca* spp., *Thyasira alleni, Kelliella abyssicola, Abra longicallus, Cuspidaria rostrata, C. abbreviata, C. costellata* Most of those species are shared with the Alboran Sea slope and Mediterranean outflow The deep community is well represented at 724 m and below, and includes *Ennucula bushae, Yoldiella messanensis, Limopsis minuta, L cristata, Amygdalum politum, Dacrydium cf hyalinum, Delectopecten vitreus, Propeamussium hypomeces, Allograma formosa, Lyonsiella subquadrata, Polycordia gemma, Cuspidaria sulcifera, C inflata, C. truncata, C. striata. Halonympha depressa,*

A factor analysis using the data in tables 1-5 converted to presence/absence of living specimens, was attempted. The most obvious factor grouping the species is depth (fig. 142). There are two well-defined groups, one of which with positive values on axis 1 corresponds to the deeper species from Balgim, the other one with negative values on axis 1 to littoral species from Fauna 1. Among the species from Fauna 1, the substrate could be another factor explaining the species groups: most of the species with negative values on axis 2 are from hard or coarse-grained substrates, whereas those with positive values originate from muddy bottoms. With regard to the relationship with water masses, the analysis is altogether less conclusive than the individual depth-plots of the species and did not bring further insight; this is predictable as some species groups are associated to water masses on transects with clearcut hydrological characters (e.g. Huelva, table 3) but are less recognizeable elsewhere (e.g. Morocco, table 4)

A plot by stations has also been made, with a similar display grouping deeper stations (Balgim and a few deeper Fauna 1 stations, e.g. 76A) on the one hand, the littoral stations mostly from Fauna 1 on the other. Depth is there again the most obvious factor, the influence of the substrate being less clearly apparent.

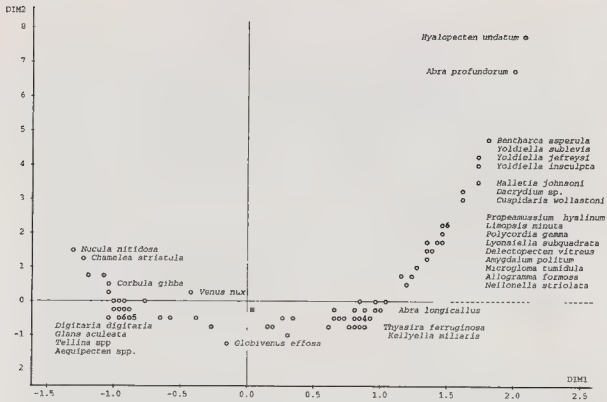

Figure 152 Plot of species in the two first dimensions of correspondence analysis Numbers indicate overlapping points, many names have been omitted for clarity.

CONCLUSIONS

There is a definite influence of the Mediterranean outflow on the distribution of Bivalves: it is a barrier which keeps out the deep water Atlantic fauna. The suite of species affected is found along the Moroccan slope as shallow as 700 m, is also found in the axis of the Strait at similar depths below the Mediterranean water, and is contained below ca. 1300 m off Huelva. Off Cape St. Vincent, the incidence of the Mediterranean outflow is very attenuated, and practically does not affect the bathymetric distribution of the Bivalves.

The distribution of the group of Thyasirids seems to follow some characteristics of the Mediterranean waters. Their bimodal distribution in the Huelva transect is consistent with the splitting of the Mediterranean flow. More generally, Thyasirids are related to oxygen-poor environments with a limited food supply, supporting an otherwise impoverished molluscan assemblage (Kauffman, 1969)

There is much similarity between the upper slope Bivalve fauna of Morocco and the slope of Alboran Sea. This may be due to similar hydrologic characteristics, which would be supported by the occurrence of *Thyasira*, or alternately to the prevalence of other environmental factors (sediment type, depth) over water mass characteristics in the distribution of these species.

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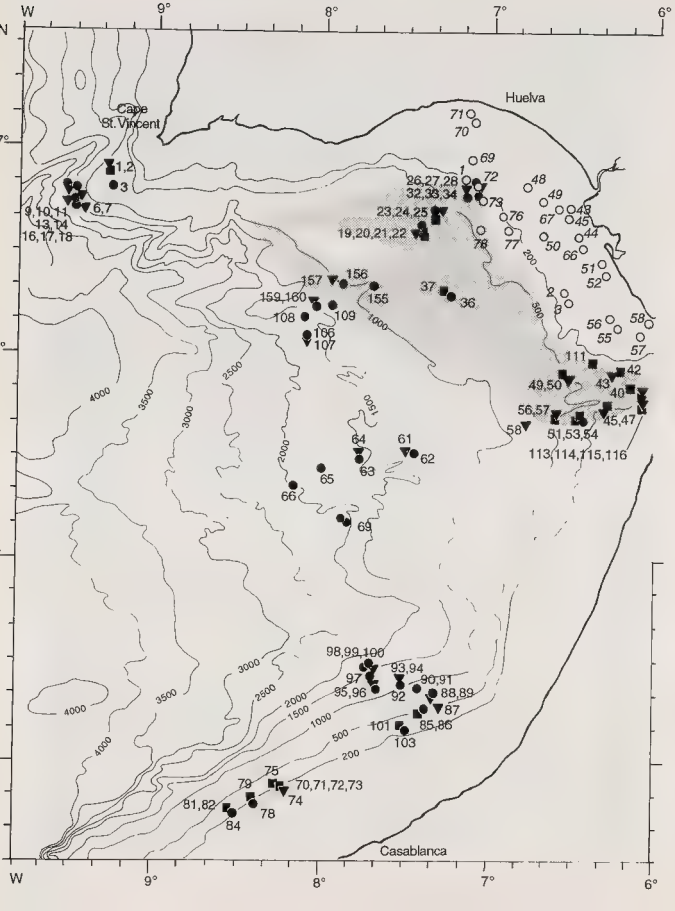
APPENDIX : List of stations

BALGIM stations in the Ibero-Moroccan Gulf

DR01	Cape St Vincent	36°53'N - 09°16'W	720 m, ooze	28.5.1984
DW02	"	36°55'N - 09°16'W	893 m, ooze	28.5.1984
CP03	"	36°50'N - 09°15'W	681 m, ooze	28 5.1984
DR06	"	36°46'N - 09°27'W	1113 m, ooze	29.5.1984
DW07	"	36°46'N - 09°27'W	1141 m, ooze	29.5.1984
CP09	"	36°48'N - 09°28'W	1163 m, ooze	29.5.1984
CP10	"	36°45'N - 09°32'W	1592 m, ooze	29.5.1984
DW11	"	36°44'N - 09°31'W	1523 m, foram. ooze	29.5.1984
DW13	"	36°42'N - 09°25'W	1378 m, ooze	30.5.1984
CP14	"	36°44'N - 09°28'W	1318 m ooze, sponges	30.5.1984
DW16	"	36°46'N - 09°29'W	1283 m, ooze	30.5.1984
CP17	"	36°45'N - 09°31'W	1470 m, ooze, sponges	30.5.1984
CP18	"	36°48'N - 09°31'W	1578 m, ooze	30.5.1984
DR19	Off Huelva	36°36'N - 07°25'W	466 m	31.5.1984
DW20	"	36°36'N - 07°24'W	452 m	31.5.1984
CP21	"	36°36'N - 07°24'W	485 m	31.5.1984
DR22	"	36°35'N - 07°24'W	466 m	31.5.1984
DR23	"	36°39'N - 07°19'W	556 m, sandy ooze	31.5.1984
DW24	"	36°41'N - 07°19'W	545 m	31.5.1984
CP25	"	36°41'N - 07°19'W	544 m, thanatocenosis	31.5.1984
CP26	"	36°45'N - 07°08'W	392 m	31.5.1984
DW27	"	36°46'N - 07°07'W	370 m	31.5.1984
DW28	"	36°46'N - 07°08'W	398 m	31.5.1984
DW32	"	36°47'N - 07°04'W	250 m, mud	1.6.1984
CP33	"	36°47'N - 07°04'W	256 m, mud	1.6.1984
CP34	"	36°49'N - 07°05'W	180 m, shell gravel	1.6.1984
CP36	"	36°17'N - 07°14'W	990 m, dead corals	1.6.1984
DR37	"	36°18'N - 07°15'W	864 m, bioclastic gravel	1.6.1984
DR40	W of the Straits	36°50'N - 06°09'W	362 m, bioclastic sand	2.6.1984
DW41	"	36°51'N - 06°10'W	340 m	2.6.1984
DR42	"	35°54'N - 06°13'W	135 m, coarse sand	2.6.1984
DW43	"	35°54'N - 06°14'W	150 m	2.6.1984
DR45	"	35°44'N - 06°17'W	293 m, pteropod ooze	2.6.1984
DW47	"	35°43'N - 06°18'W	281 m, muddy sand	2.6.1984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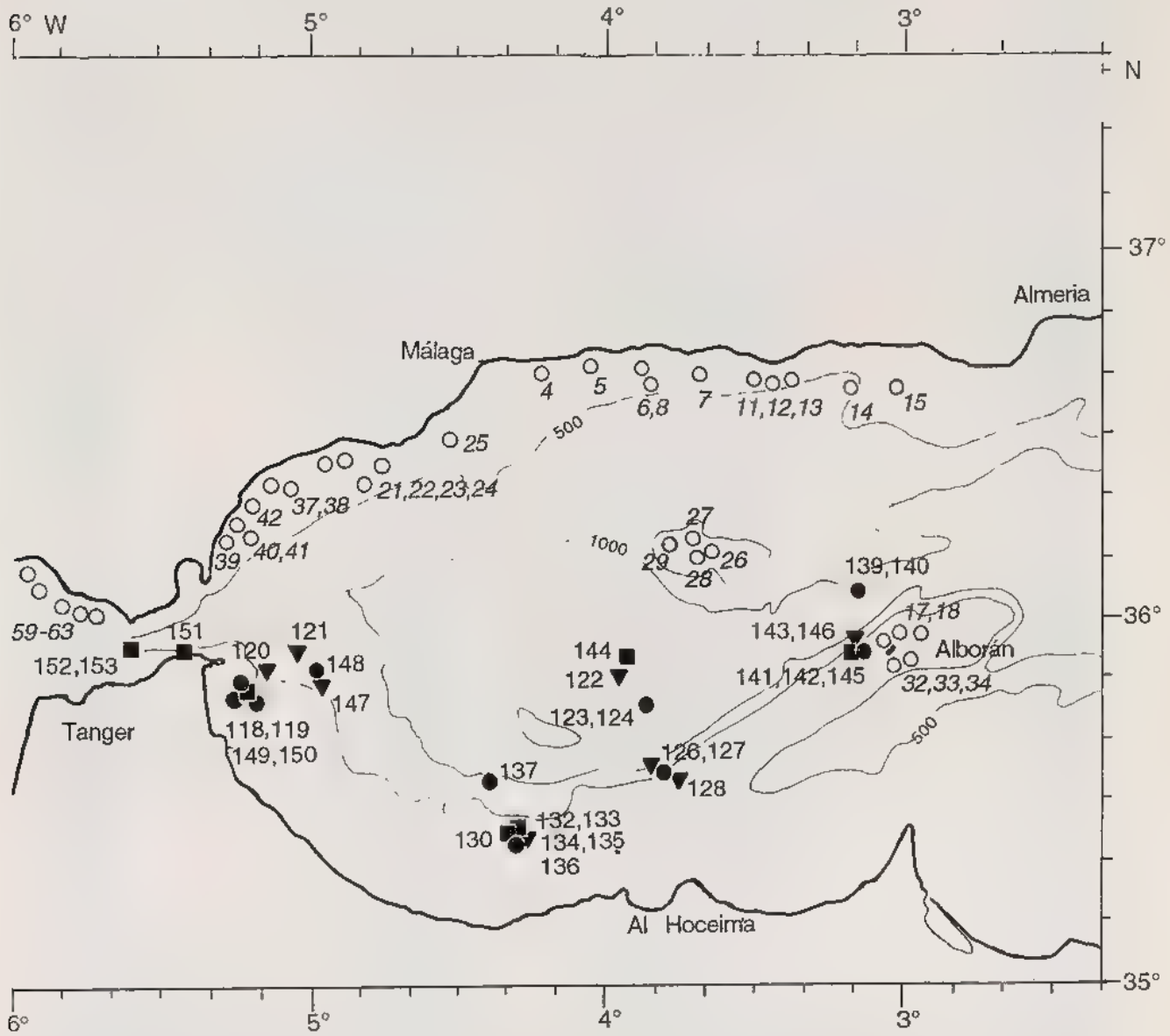

Figure 153 Map of stations Open circles and italic numbers Fauna 1 stations Black symbols and roman numbers Balgim stations (circles beam trawl, squares. rock dredge, triangles Warén epibenthic sled) The stippled area indicates approximately the extension of the Mediterranean outflow in the Atlantic

DR49	"	35°53'N - 06°33'W	521 m, coarse bioclasts	2.6.1984
DW50	"	35°53'N - 06°32'W	523 m	3.6.1984
DR51	"	35°41'N - 06°29'W	362 m	3.6.1984
DW53	"	35°41'N - 06°30'W	364 m, pteropod ooze	3.6.1984
CP54	"	35°41'N - 06°30'W	356 m	3.6.1984
DR56	"	35°41'N - 06°36'W	481 m, sandy ooze	3.6.1984
DW57	"	35°42'N - 06°35'W	548 m, sand with shells	3.6.1984
DW58	"	35°39'N - 06°46'W	826 m, pteropod ooze	3.6.1984
DW61	"	35°31'N - 07°26'W	1222 m	4.6.1984
CP62	"	35°31'N - 07°26'W	1250 m, ooze, sponges	4.6.1984
CP63	"	35°31'N - 07°42'W	1510 m, pteropod ooze	4.6.1984
DW64	"	35°30'N - 07°46'W	1530 m, pteropod ooze	4.6.1984

CP65	"	35°26'N - 08°00'W	1805 m	4.6.1984
CP66	"	35°21'N - 08°10'W	2110 m	5.6.1984
CP68	"	35°12'N - 07°53'W	2035 m, ooze, corals	5.6.1984
CP69	"	35°11'N - 07°50'W	2028 m, ooze, corals	5.6.1984
DR70	Off Casablanca	33°52'N - 08°06'W	147 m, mud and shells	6.6.1984
DR71	"	33°52'N - 08°07'W	155 m, mud and shells	6.6.1984
DR72	"	33°52'N - 08°12'W	173 m, mud and shells	6.6.1984
DR73	"	33°52'N - 08°13'W	181 m, mud ans shells	6.6.1984
DW74	"	33°52'N - 08°13'W	181 m, sandy mud	6.6.1984
DR75	"	33°53'N - 08°15'W	252 m, shell sand	6.6.1984
CP78	"	33°49'N - 08°22'W	248 m	6.6.1984
DR79	"	33°49'N - 08°24'W	260 m, shell sand	6.6.1984
DR81	"	33°46'N - 08°30'W	309 m, sand	6.6.1984
DR82	"	33°45'N - 08°32'W	355 m	6.6.1984
CP84	"	33°45'N - 08°32'W	345 m	6.6.1984
DR85	Off Rabat	34°14'N - 07°24'W	497 m, coarse shell sand	7.6.1984
CP86	"	34°15'N - 07°21'W	512 m, ooze	7.6.1984
DW87	"	34°16'N - 07°18'W	500 m	7.6.1984
DW88	"	34°20'N - 07°19'W	740 m, pteropod ooze	7.6.1984
CP89	"	34°20'N - 07°18'W	722 m, ooze	7.6.1984
CP90	"	34°21'N - 07°24'W	890 m, ooze, sponges	7.6.1984
CP91	"	34°22'N - 07°25'W	948 m, ooze, sponges	7.6.1984
CP92	"	34°24'N - 07°30'W	1182 m	8.6.1984
DW93	"	34°24'N - 07°31'W	1203 m	8.6.1984
DW94	"	34°25'N - 07°28'W	1175 m, ooze	8.6.1984
CP95	"	34°24'N - 07°39'W	1378 m, ooze, hard-ground	8.6.1984
DW96	"	34°23'N - 07°40'W	1255 m	8.6.1984
CP97	"	34°25'N - 07°41'W	1515 m	8.6.1984
CP98	"	34°29'N - 07°42'W	1747 m	9.6.1984
CP99	"	34°28'N - 07°43'W	1870 m, ooze	9 6.1984
DW100	"	34°28'N - 07°22'W	1691 m, pteropod ooze	9.6.1984
DR101	"	34°11'N - 07°30'W	353 m, ooze	9.6.1984
CP103		34°11'N - 07°30'W	347 m	9.6.1984
CP106	Off Huelva	36°05'N - 08°05'W	1906 m	10.6.1984
DW107	"	36°05'N - 08°06'W	1917 m	10.6.1984
CP108	"	36°11'N - 08°06'W	1527 m	10.6.1984
CP109	"	36°14'N - 07°56'W	1200 m, sticky mud	10.6.1984
DR111	W of Cape Spartel	35°57'N - 06°22'W	285 m	11.6.1984
DR113	"	35°45'N - 06°05'W	144 m, coarse shell sand	11.6.1984
DW114	"	35°45'N - 06°04'W	150 m	11.6.1984
DR115	"	35°47'N - 06°04'W	332 m, coarse bioclasts	11.6.1984
DW116	"	35°49'N - 06°04'W	340 m	11.6.1984

BALGIM stations in Alboran Sea:

DR118	E of Ceuta	35°48'N - 05°12'W	352 m, grey mud	13.6.1984
CP119	"	35°50'N - 05°13'W	517 m	13.6.1984
DW120	"	35°51'N - 05°10'W	425 m	13.6.1984
DW121	"	35°56'N - 05°02'W	570 m	13.6.1984
DW122	W. Alboran Basin	35°51'N - 03°57'W	905 m	14.6.1984
CP123	"	35°47'N - 03°52'W	1234 m	14.6.1984
CP124	"	35°46'N - 03°52'W	1405 m	14.6.1984

DW126	Alboran Ridge	35°36'N - 03°51'W	998 m	14.6.1984
CP127	"	35°35'N - 03°48'W	720 m, mud	14.6.1984
DW128	"	35°35'N - 03°45'W	480 m, mud, dead corals	14.6.1984
DR130	Xauen Bank	35°25'N - 04°19'W	145 m, coarse bioclasts	15.6.1984
DW132	"	35°26'N - 04°19'W	170 m, coarse bioclasts	15.6.1984
DR133	"	35°26'N - 04°17'W	195 m, coarse bioclasts	15.6.1984
DW134	"	35°26'N - 04°17'W	205 m	15.6.1984
CP135	"	35°26'N - 04°14'W	395 m, mud, dead corals	15.6.1984
DW136	"	35°26'N - 04°18'W	298 m, shell debris	15.6.1984
CP137	W. Alboran basin	35°33'N - 04°23'W	1005 m, mud	15.6.1984
CP139	"	36°05'N - 03°09'W	1275 m	16.6.1984
CP140	"	36°05'N - 03°03'W	1738 m	16.6.1984
DR141	"	35°56'N - 03°06'W	170 m	16.6.1984
DW142	"	35°57'N - 03°06'W	167 m	16.6.1984
DW143	"	35°57'N - 03°07'W	252 m	16.6.1984
DR144	"	35°56'N - 03°56'W	314 m, sandy mud	16 6.1984
CP145	"	35°57'N - 03°08'W	373 m, mud and shells	16.6.1984
DW146	"	35°56'N - 03°09'W	555 m	16.6.1984
DW147	E of Ceuta	35°50'N - 04°58'W	489 m, soft mud	17.6.1984
CP148	"	35°52'N - 04°59'W	508 m	17.6.1984
CP149	"	35°47'N - 05°11'W	377 m	17.6.1984
CP150	"	35°47'N - 05°17'W	290 m	17.6.1984
DR151	Benzú	35°55'N - 05°25'W	115 m, concretions	17.6.1984
DR152	Strait of Gibraltar	35°57'N - 05°35'W	550 m, dead corals	17.6.1984
DR153	"	35°56'N - 05°35'W	580 m	17.6.1984
CP155	Off Huelva	36°20'N - 07°41'W	903 m	18.6.1984
CP156	"	36°20'N - 07°53'W	1135 m, coarse sand	18.6.1984
DW157	"	36°21'N - 07°56'W	1108 m	18.6.1984
DW159	"	36°15'N - 08°02'W	1360 m, soft ooze	18 6.1984
CP160	"	36°15'N - 08°00'W	1350 m, ooze	18.6.1984

FAUNA 1 stations

1A	Off Huelva	36°51,62' N - 07°10,27' W	190 m, mud	9.7.1989
2A	Off Trafalgar	36°22,76' N - 06°36,79' W	118-116 m, detritic	9.7.1989
3A	"	36°23,58' N - 06°37,27' W	116-114 m, detritic	9.7.1989
4A	Alboran Sea	36°40,34' N - 04°11,55' W	60 m, muddy sand	10.7.1989
5A	"	36°41,93' N - 04°04,88 W	68-67 m, mud	10.7.1989
6A	"	36°43,79' N - 03°51,78' W	70-74 m, muddy sand	10.7.1989
7A	"	36°41,26' N - 03°43,15' W	96-84 m, muddy sand	10.7.1989
8A	"	36°41,06' N - 03°48,36' W	291-238 m,	10.7.1989
11A	"	36°40,53' N - 03°28,76' W	60-110 m, rocks and mud	11.7.1989
12A	"	36°41,10' N - 03°29,41' W	64-62 m, rocks	11.7.1989
13A	"	36°40,89' N - 03°22,59' W	62 m, coarse gravel	11.7.1989
14A	"	36°41,00' N - 03°18,32' W	285-290 m, mud	11.7.1989
15A	"	36°38,42' N - 03°03,98' W	306-274 m, mud	11.7.1989
17A	"	5°57,80' N - 03°00,10' W	74-70 m, rocks	12.7.1989
18A	"	5°57,18' N - 03°01,92' W	45-52 m, rocks	12.7.1989
21A	"	6°24,32' N - 04°55,11' W	164-130 m, detritic	13.7.1989
22A	"	6°25,20' N - 05°00,80' W	30 m, coralline algae	13.7.1989
23A	"	6°24,05' N - 05°00,99' W	30-32 m, coralline algae	13.7.1989
24A	"	6°27,36' N - 04°46,50' W	78-74 m, muddy sand	13.7.1989

25A	"	6°28,20' N - 04°30,99' W	233-227 m, mud	13.7.1989
26A	"	6°10,81' N - 03°44,29' W	296-297 m, muddy sand	14.7.1989
27A	"	6°10,85' N - 03°44,15' W	297-288 m, muddy sand	14.7.1989
28R	"	6°11,12' N - 03°45,11' W	308 m, muddy sand	14.7.1989
29A	"	6°12,20' N - 03°47,90' W	411-400 m, mud	14.7.1989
32A	"	5°55,85' N - 03°02,77' W	28 m, *Laminaria* , rocks	15.7.1989
33A	"	5°55,95' N - 03°01,56' W	34-44 m, *Laminaria* , r.	15.7.1989
34A	"	5°57,83' N - 03°00,50' W	69-62 m, rocks w/cavities	15.7.1989
37A	"	6°18,95' N - 05°10,60' W	100-95 m, coarse gravel	16.7.1989
38A	"	6°18,25' N - 05°13,25' W	62-60 m, gravel	16.7.1989
39A	"	6°12,2' N - 05°18,81' W	21-23 m, detritic/algae	16.7.1989
40R	"	6°13,00' N - 05°18,08' W	21 m, detritic/algae	16.7.1989
41R	"	6°13,2' N - 05°18,20' W	18-16 m, phot. algae	16.7.1989
42A	"	6°12,15' N - 05°16,81' W	87-86 m, detritic	16.7.1989
43A	Off Cádiz	36°36,76' N - 06°26,66' W	24-20 m, rocks/corals	18.7.1989
44A	"	36°33,80' N - 06°24,12' W	25-26 m, mud	18.7.1989
45A	"	36°36,28' N - 06°24,29' W	18 m, rocks/corals	18.7.1989
48A	"	36°48,11' N - 06°48,75' W	62 m, mud	19.7.1989
49A	"	36°38,29' N - 06°53,04' W	240-238 m, mud	19.7.1989
50A	"	36°33,09' N - 06°44,71' W	122-108 m, mud	19.7.1989
51A	"	36°24,23' N - 06°18,08' W	28-27 m, rocks and mud	
52A	"	36°22,60' N - 06°15,78' W	24-22 m, rock	19.7.1989
55A	Strait of Gibraltar	36°05,91' N - 06°08,40' W	38-42 m, gravel	20.7.1989
56A	"	36°09,81' N - 06°09,21' W	24 m, rocks and gravel	20.7.1989
57A	"	36°04,84' N - 06°01,00' W	80-76 m, rocks and gravel.	20.7.1989
58A	"	36°08,60' N - 06°01,20' W	34-33 m, detr. w/rocks	20.7.1989
59A	"	36°02,63' N - 05°41,52' W	20 m, rocks/*Laminaria*	21.7.1989
60A	"	36°03,33' N - 05°41,23' W	12-16 m, rock, sand, algae	21.7.1989
61A	"	36°01,07' N - 05°40,04' W	39-44 m, rocks	21.7.1989
62A	"	36°04,00' N - 05°55,29' W	92-94 m, rocks	21.7.1989
63A	"	36°03,13' N - 05°50,58' W	97-118 m, detritic	21.7.1989
66A	Off Cádiz	36°30,90' N - 06°22,10' W	25-28 m, muddy sand	22.7.1989
67A	"	36°40,58' N - 06°40,20' W	56-55 m, mud	22.7.1989
69A	Off Huelva	36°57,04' N - 07°20,93' W	110-112 m, mud	23.7.1989
70A	"	37°07,08' N - 07°12,27' W	22 m, gravel and rocks	23.7.1989
71A	"	37°09,48' N - 07°13,56' W	15-13 m, muddy sand	23.7.1989
72A	"	36°48,05' N - 07°18,45' W	468-450 m, muddy sand	23.7.1989
73A	"	36°42,02' N - 07°14,70' W	509-500 m, mud	23.7.1989
76A	"	36°36,30' N - 07°19,08' W	535-546, muddy sand	24.7.1989
77A	"	36°33,94' N - 07°06,50' W	500-504 m, mud	24.7.1989
78A	"	36°34,29' N - 07°06,89' W	508-498 m, mud	24.7.1989

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The genus *Okenia* Menke, 1830 (Nudibranchia: Goniodorididae) in Chile

María Angélica MUÑOZ [1], *Ángel VALDÉS* [1] *and Jesús ORTEA* [1]

RÉSUMÉ

Le genre *Okenia* Menke, 1830 (Nudibranchia: Goniodorididae) au Chili

Cet article réexamine deux espèces du genre *Okenia* citées des côtes du Chili Les données publiées indiquent que l'une d'entre elles est *Okenia angelensis* Lance, 1966, une espèce originellement décrite de Basse-Californie. L'autre est *Okenia luna* Millen, Schrödl, Vargas & Indacochea, 1994 décrite des côtes du Pérou et du Nord du Chili.

De nouvelles données sont apportées sur l'anatomie et la distribution géographiques de *O. angelensis* et *O. luna* are given. Les caractères morphologiques externes et l'anatomie des deux espèces sont discutés, et comparés à ceux des autres espèces pacifiques et atlantiques du genre *Okenia*.

ABSTRACT

This paper examines two species of the genus *Okenia* recorded from Chile, South America. A full review of the literature reveals that one of them is *Okenia angelensis* Lance, 1966, a species originally described from Baja California. The other one is *Okenia luna* Millen, Schrödl, Vargas & Indacochea, 1994 described from the Peruvian and North Chile coast.

New data about the anatomy and geographical distribution of *O. angelensis* and *O. luna* are given. Both, anatomical and external features of these species are discussed, and compared with those of other Pacific and Atlantic species of the genus *Okenia*.

INTRODUCTION

The genus *Okenia* Menke, 1830 is known from the Pacific, Indian and Atlantic Oceans. These animals are very difficult to collect, because they appear very occasionally, usually over cryptic habitats (off their food: ascidians or bryozoans) and rarely in large numbers. The knowledge of this genus is quite limited, even in well studied geographical areas.

In the Pacific Ocean, 14 species of the genus *Okenia* have been reported, one of them recently described (Millen *et al.*, 1994). A complete list of the world species of this genus is given by Vogel and Schultz (1970).

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The geographical distribution of the genus *Okenia* in the Pacific Ocean is the following: seven species in Japan (*O barnardi* Baba, 1937, *O distincta* Baba, 1940; *O. japonica* Baba, 1949; *O. echinata* Baba, 1949; *O opuntia* Baba, 1960; *O. plana* Baba, 1960 and *O. babai* Hamatani, 1961); two species in North America (*O. vancouverensis* O'Donoghue, 1921 and *O. angelensis* Lance, 1966); one species on the Chinese coast (*O. tentaculata* Stimpson, 1855); another one from Vietnam (*O. plebeia* Bergh, 1802); two species in Australia (*O. mija* Burn, 1967 and *O. pellucida* Burn, 1967); and another one from South America, *O. luna* Millen, Schrodl, Vargas & Indacochea, 1994.

This paper deals with material of *O. angelensis* and *O. luna* collected from the coast of Chile.

SYSTEMATIC PART

Family Goniodorididae H. & A. Adams, 1859
Genus *Okenia* Menke, 1830
Type species *Idalia elagans* Leuckart, 1828

***Okenia angelensis* Lance, 1966** (Figure 1)

References:
Okenia angelensis Lance, 1966: 76-78; figs. 9-12 - Burn 1967: 55 - Sphon & Lance 1968: 80 - Roller & Long 1969: 427 - Keen 1971: 829, pl. XXI, 2 - Abbott 1974: 363 - Behrens 1980: 64 - Farmer 1980: 135 - McDonald 1983: 195 - Schmekel 1979: 357.
Cargoa angelensis (Lance). Vogel & Schultz 1970: 389.

Material:
Hueihue, Bahía de Manao, Ancud, Chile (41°54'S, 73°28'W), 16.XII.1991, -2 to -3 m depth, 4 specimens 4 to 6 mm long alive. Deposited in the Museo Nacional de Historia Natural of Santiago, Chile (MNHN 201619).

Description:

The body color is hyaline yellow, with oval red spots and groups of white dots all over the dorsum (fig. 1A). The body is elongated, with two conspicuous oral tentacles. There are two rows of 7 tubercles, shaped like chess pawns, on each side of the body. In the center of the dorsum, between the rhinophores and the branchial leaves, there are 8 tubercles, very close to the lateral ones. In the front, over the head there are 2 tubercles with the same shape as the former The rhinophores are red, conical with two cup-shaped lamellae (fig, 1A). There are 7 branchial leaves, of yellow colour.

The genital system (fig. 1B) bears a very large and swollen ampulla. The prostatic portion of the deferent duct is short. No penial hooks were observed

The bucal bulb bears a large pump (fig. 1C) and two orange salivary glands. The radular formula is 18x(1.1.0.1.1) in the 6 mm specimen. The inner lateral teeth (fig. 1D) have 23 hard denticles on their cusps. The outer lateral teeth bear two cusps. There are no jaws.

Geographical Range:

This species is known from San Francisco Bay, California, U.S A. to Bahía de Los Angeles, Baja California, Mexico (Lance, 1966; McDonald, 1983). This is the first record from Chile and the South Pacific.

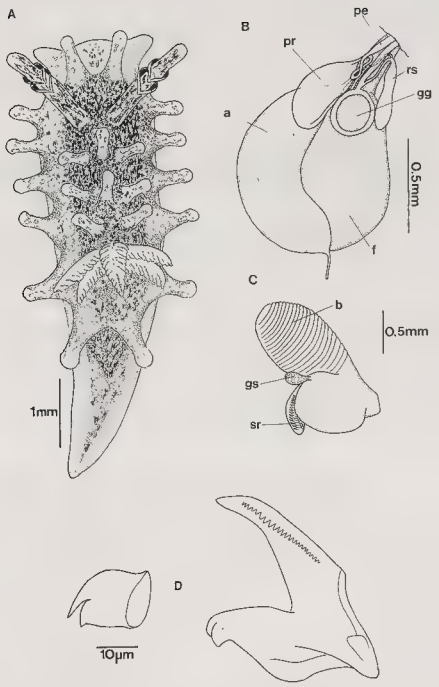

Figure 1. *Okenia angelensis* (MNHN 201619) A Dorsal view of the living animal, B. Structure of the genital system, C. Bucal bulb showing the pump and the salivary glands, D. Half-row of the radula a· ampulla, b. pump, f· female gland, gs. salivar gland, gg gametolytic gland, sr seminal receptacle, pe penis, pr prostate; rs· seminal receptacle

***Okenia luna* Millen, Schrödl, Vargas & Indacochea, 1994** (Figure 2)

References:
Okenia luna Millen *et al.*, 1994: 314-317.

Material:
Bahía de Iquique, 1st region of Chile (22° 13' S, 70° 08' W), 10.VI.1993, -26 m depth, 1 specimen 5 mm long preserved. Deposited in the Museo Nacional de Historia Natural of Santiago, Chile (MNHN 201618).

Description:

The body colour is hyaline white, with a soft pink hue. The skin is smooth. The mantle (fig. 2A) has an edge with several triangular papillae, 5 on each side and another two in front, over the head.The rhinophores have 10 lamellae on their frontal side. There are 9 unipinnate branchial leaves, surrounding the anus The head (fig. 2C) has two wide and short oral tentacles. There is a tail on the back of the body.

The radular formula is 26x(1.1.0.1.1) in the specimen studied. The outer lateral teeth (fig. 2E) are rounded in shape, with a little cusp, where the lateral teeth are inserted. The inner lateral teeth have 22 to 32 denticles. Over their bases there is a little rounded plate, similar to a fish scale. The jaws (fig. 2D) have uncini variable in shape and size. Most of them are rectangular in shape with 4 to 6 cusps. The penis (fig 2B) is strong, elongate and has a row of hooks on each side.

Geographical range:
This species is known from the Pacific coast of South America, from Peru to the north of Chile.

DISCUSSION

At the moment, the information gathered about the species of the genus *Okenia* is very irregular, because different criteria have been used to describe species. In this study, we considered factors such as the presence and number of dorsal papillae, the morphology of dorsal and lateral papillae, the number of branchiae, the type and shape of rhinophores, the body colour and the morphology of radular teeth.

O. angelensis is characterized by its 8 appendages in the dorsum distributed ahead to the branchiae. A review of the literature (Baba, 1949; Baba, 1960; Hamatani, 1961; Burn, 1967) reveals that there are other species of the genus *Okenia* in the Pacific Ocean with dorsal papillae: *O. echinata*, *O. japonica*, *O plana*, *O. pellucida*, *O. babai* and *O. mija*. Nevertheless, the morphology, disposition and size of the papillae of most of this species are very different of those of *O. angelensis*, as well as the morphology of their radular teeth. Only the external morphology of *O. mija* is extremely similar to *O. angelensis* (Burn, 1967), in coloration, morphology of the lateral and dorsal papillae and rhinophores shape; but according to Burn (com. pers). *O. mija* is smaller than *O. angelensis* and has fewer lateral and dorsal appendages. Also *O. mija* has more rhinophoral lamellae (the usual number of lamellae is 4, but sometimes there is 1-6), they are on the rear face only and comprise a bilobed fold.

O. zoobotryon (Smallwood, 1910) is one Atlantic species known from the Bermuda Islands to the south of Brazil. The external morphology of this species is very similar to *O. angelensis*, but its dorsal papillae are irregular in size and occur in the center of the dorsum (Clark, 1984), contrary to those of *O. angelensis* which are distributed uniformly and are all of similar size. Also, this species is very different in the radular morphology (Valdés and Ortea, 1995).

O. luna is characterized by the absence of dorsal papillae. There is only one other species of the genus *Okenia* described in the Pacific Ocean without dorsal papillae, *O. barnardi* (Baba, 1937). It is clearly different from *O. luna* by having elongated and tentacular lateral papillae. There are no data about the anatomy of *O. barnardi*.

The radula of *O. luna* is very similar to that of *O opuntia* (Baba, 1960), especially in the marginal teeth. Nevertheless, the lateral teeth of *O. opuntia* do not have a little plate over it, as do the lateral teeth of *O. luna* . The external morphology of both species is very different.

The Atlantic species of *Okenia* related to *O luna* have been discussed by Millen *et al.* (1994).

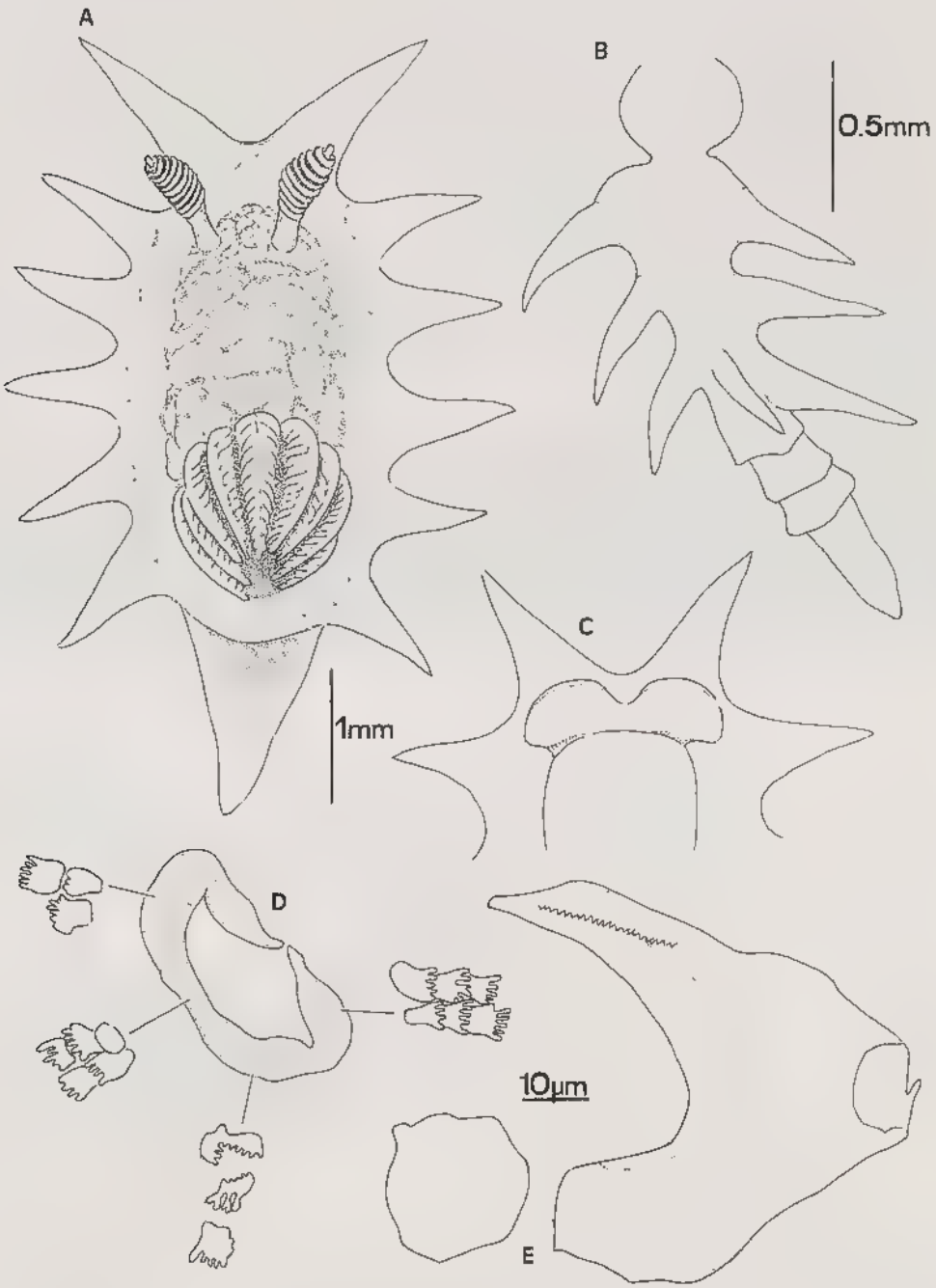

Figure 2. *Okenia luna* (MNHN 201618) A. Dorsal view of the preserved animal, B. Penis, C Jaws, showing the shape of the plates, E. Half-row of the radula.

ACKNOWLEDGMENTS

We gratefully acknowledge the Centro de Investigaciones Marinas of Hueihue, Ancud (Instituto de Fomento Pesquero) for allowing us to enter their floating docks for collecting specimens, and specially Dr. Wington Palma (Universidad Arturo Pratt of Iquique) for making one specimen of *O. luna* available. Dr. Robert Burn (Australia) is warmly acknowledged for having made available unpublished data on *O. mija*

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Kaiparapelta askewi McLean & Harasewych, 1995 (Gastropoda: Pseudococculinidae): a spongivorous cocculiniform limpet and a case of remarkable convergence in radular morphology

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RÉSUMÉ

Kaiparapelta askewi McLean & Harasewych, 1995 (Gastropoda. Pseudococculinidae), **un gastéropode cocculiniforme spongivore, et un cas remarquable de convergence dans la morphologie radulaire**

Les premiers exemplaires récoltés vivants de *Kaiparapelta askewi* sont cités du banc Atlantis, dans l'Atlantique Nord. L'habitat, la morphologie externe des parties molles, la radula et la coquille sont décrites. Les caractères morpho-anatomiques confirment le placement dans la famille des Pseudococculinidae (Cocculiniformia), malgré une radula qui par elle même suggérerait une affinité avec des opisthobranches notaspides ou chromodoridides. Ceci est considéré comme une convergence, expliquée par le régime alimentaire présumé spongivore

ABSTRACT

The first live taken specimens of *Kaiparapelta askewi* are reported from Atlantis Seamount in the North Atlantic. The habitat, external morphology of the soft parts, the radula and the shell are described. From the morphological and anatomical features, the classification in the Pseudococculinidae (Cocculiniformia) is confirmed, despite a radula which alone suggests more affinity to notaspidean or chromodorid opistobranchs. This is considered a convergence and is ascribed to assumed spongivory

INTRODUCTION

The group Cocculiniformia is a diverse assemblage of "Archaeogastropod" limpets, usually restricted to deep water and usually with species- or group-specific requirements on the substrate. Species may live on sunken pieces of drift wood, old whale skeletons, turtle carapaces, cephalopod beaks and many other kinds of biogenic matter. Haszprunar (1988b) reviewed the classification and Marshall (1983a, 1986, 1987, 1994) and McLean (1985, 1987, 1991, 1995) have contributed much to the knowledge on the taxon. Dantart & Luque (1994) reviewed the species occurring around the Iberian Peninsula. Most additional references of interest will be found in these papers.

The Cocculiniformia contains species of highly variable morphology in the soft parts and radula. The variation of the shell is somewhat restricted since almost all species have a limpet shaped shell (coiled in Choristellidae). Usually there are no great problems to distinguish the species, which differ in details in shell sculpture, minor features in the radula, or male

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reproductive organs and neatly form natural groups, which have been used as genera (or families when the differences are "great").

We have, however, noticed that within the Cocculiniformia there is a surprisingly high number of families with a single genus (Osteopeltidae, Cocculinellidae, Lepetellidae, Addisoniidae, Pyropeltidae among 10 families) and believe that for some of these taxa "great" and "striking" morphological differences have been guiding the taxonomists, instead of a search for similarities.

MATERIAL AND METHODS

The new material of *Kaiparapelta askewi* was obtained during the Seamount 1 (R/V "Le Noroît", September-October 1987) and Seamount 2 (R/V "Le Suroît" January-February 1993) cruises, granted for Prof. P. Bouchet, (Muséum National d'Histoire Naturelle (MNHN), Paris), by the Centre National de la Recherche Scientifique (CNRS/INSU). The Seamount project was targeted to understanding the colonization of Northeast Atlantic oceanic seamounts by the benthic fauna. Some material was sorted on board the vessels and notes were taken on live animals. Other material was sorted at the Swedish Museum of Natural History, Stockholm (SMNH: Seamount 1) and MNHN (Seamount 2); the material is to be shared and deposited in the collections of both institutions.

Two of the live taken specimens were critical point dried via aceton and carbon dioxide and examinèd with SEM. One of these was afterwards used for examination of the radula.

SYSTEMATIC PART

Class Gastropoda
Order Cocculiniformia
Family Pseudococculinidae Hickman, 1983

Remarks: The Pseudococculinidae is the largest family of the Cocculiniformia, with 9 genera recognised by Marshall (1986), four added by Haszprunar (1988a), and two by McLean (1991). Hickman (1983) and Marshall characterised the family only from radular features. Haszprunar (1988a,b) added the following external features to the characterization, in addition to internal ones:
- Presence of a right cephalic copulatory tentacle and sperm tract (shared with most other families in the Cocculiniformia).
- A single pair of posteriorly situated epipodial tentacles (shared with most other families).
- A series of "secondary" gill leaflets with sensory bursicles of varying arrangement. (shared with some other families).
- Pallial margin papillose (shared with most other cocculiniforms).
- Sensory papillae of vetigastropod type (in other cocculiniforms with certainty known only from the Choristellidae, a normally coiled family not discussed further in this paper).

The teleoconchs are quite variable in shape and sculpture, but one feature shared by all species Marshall included in the family is the gross morphology of the protoconch with the initial part drawn out to two pocket like structures along the side (figure 2A-B). Such structures are not present in the Cocculinidae or Bathysciadiidae (Marshall 1986; Warén, in press,), where the protoconch is normally coiled. The protoconch is not known in the Pyropeltidae and Bathyphytophilidae. A pseudococculinid type protoconch is known from Cocculinellidae (Marshall 1983a), Osteopeltidae (Marshall 1994), Lepetellidae (Warén 1991) and in the Addisoniidae (Dantart & Luque 1994; but Warén (in press) has questioned this identification).

Kaiparapelta Marshall, 1986

Type species *Kaiparapelta singularis* Marshall, 1986, by original designation, Early Miocene, New Zealand.

Remarks. Unaware of the soft part morphology (the type species is fossil), Marshall (1986) classified *Kaiparapelta* in the Pseudococculinidae because of similarities to species of *Notocrater* Finlay, 1927 in shell sculpture and protoconch features. Haszprunar (1988b) without giving any reason considered *Kaiparapelta* a subgenus of *Notocrater* Finlay, 1927 (the species of which have a tuberculate sculpture).

Our specimens were found alive on deep-sea sponges, but the preservation was not very successful and not suitable for anatomical work, so our information is limited to observations on numerous shells, three living specimens (of which two were critical point dried), and the radula. These are reported below under the specific heading. (The preliminary results were made available to McLean & Harasewych (1995) and were the basis for the classification of their new species.)

We consider the following features useful for determining the systematic position of *Kaiparapelta*:

- Protoconch with initial part drawn out to pocket-like structures. Present in Pseudococculinidae, Lepetellidae, Addisoniidae(?), Osteopeltidae, and Cocculinellidae. Regularly coiled in Cocculinidae, Basthysciadiidae, not known in other families.

- Posterior part of foot with a paired, epipodial tentacle. Present in Pseudococculinidae, Pyropeltidae, Osteopeltidae; variable in Cocculinidae. Absent in Lepetellidae, Bathysciadiidae, and Addisoniidae.

- Cephalic tentacles with sensory papillae. Present in Pseudococulinidae. Absent in Addisoniidae, Bathysciadiidae, Lepetellidae, Cocculinidae; not known in other taxa.

- A series of respiratory leaflets in outer right part of pallial cavity, reaching back to the epipodial tentacle. Similar to Pseudococculinidae, Osteopeltidae, and Pyropeltidae.

- Right side of neck and right cephalic tentacle with sperm tract. Many Cocculinidae and all Bathysciadiidae have a penis at the right cephalic tentacle. Others usually as in *Kaiparapelta*.

From this we conclude that *Kaiparapelta* should be placed in the Pseudococculinidae, as originally suggested by Marshall (1986).

The radula is strongly deviating from most archaeogastropods and comparable only to that of the Trochaclididae where some species have a short and broad radula with a rather uniform tooth morphology along the transverse rows (Warén 1992, Marshall 1995). These teeth do, however, differ in being erect and leaf-shaped, apically equipped with a brush- or feather-like appendage instead of posteriorly directed cusps. We therefore consider the similarity a convergence. (Furthermore, the Trochaclididae have a basically trochoid soft part morphology with a monopectinate gill and a normally coiled shell without a tendency towards limpet shape.)

The radula of *Kaiparapelta* actually resembles that of many sponge feeding opisthobranchs, especially of the Notaspidea and the Chromodorididae (for example, see Rudman 1985:fig. 25 E) and we believe it to be an adaptation to spongivory and therefore not suited for comparison with plesiomorphic radulae. Parallels to this radula type can also be seen in the Triphoridae which are sponge feeding species of the Neotaenioglossa (e.g. Marshall 1983b, Bouchet & Warén 1993).

Kaiparapelta askewi McLean & Harasewych, 1995 (figures 1-6)

Kaiparapelta askewi McLean & Harasewych, 1995:28.

Type material. Holotype U.S. National Museum 860362, Paratype Los Angeles County Museum of Natural History 2740.

Type locality. Off South Carolina, 32°43.68'N, 78°05.72'W, 198 m.

Figure 1A-K. *Kaiparapelta askewi*, shell, exterior A-E Seamount 2 DW274, 3 0 mm. D. Detail of interior, muscle scar. E. Detail of sculpture F-G Seamount 1 DW41, 2 1 mm. H-I Seamount 2 DW274, 3 5 mm. J-K. Seamount 2 DW209, 4.5 mm.

Material examined. **Gran Canaria,** Seamount 2 DW133, 28°01 3'N, 15°53 5'W, 215-195 m, 2 shells (MNHN). **Off southwestern Portugal,** Gorringe Bank, Seamount 1 CP20, 36°33.7'N, 11°30 1'W, 305-320 m, 1 shell (MNHN). Josephine Bank, Seamount 1 DW41, 36°40.1'N, 14°14 9'W, 200 m, 2 shells (MNHN), Seamount 1 DW43, 36°44.9'N, 14°17 3 W, 260-285 m, many shells (SMNH, MNHN), Seamount 1 DW45, 36°45 8'N, 14°17 5'W, 315-335 m, 5 shells (SMNH) Josephine Bank, 200-250 m, JOSEPHINE Expedition 1869, 1 shell (SMNH). Seine Bank, Seamount 1 DE72, 33°45 2 N, 14°21.0 W, 165 m, 1 shell (SMNH), Seamount 1 DE80, 33°48.5'N, 14°22 6'W, 250-256 m, 1 shell (MNHN) Ampère Bank, Seamount 1 DE95, 35°04 6'N, 12°55 3'W, 197-210 m, 1 shell (SMNH); Seamount 1 DE98, 35°03.2'N, 12°55 4'W, 300-325 m, 6 shells (SMNH). **Mid-Atlantic, South of the Azores,** Great Meteor Bank, Seamount 2 DW143, 30°09 9'N, 28°28 3'W, 330-325 m, 1 shell (MNHN). Seamount 2 DW152, 30°02.1'N, 28°22 2'W, 480 m, 1 shell (MNHN) Hyères Seamount, Seamount 2 DW188, 31°30.0'N, 28°59 5'W, 300-310 m, 53 shells (MNHN, SMNH). Irving Seamount, Seamount 2 DW209, 31°59 1'N, 28°01'W, 260 m, 2 shells (SMNH). Atlantis Seamount, Seamount 2 DW255, 34°05 0'N, 30°15 3'W, 340-335 m, 65 shells (MNHN, SMNH) Seamount 2 DW274, 34°05'N, 30°13 7'W, 280 m, 3 specimens attached on a piece of the sponge *Pachastrella monilifera* Schmidt, 1868 (Pachastrellidae, Choristidae, identified by O. Tendal) (MNHN), and 118 shells (MNHN, SMNH). Tyro Seamount, Seamount 2 DW278, 33°57.6'N, 28°22.4'W, 890-925 m, 3 shells (SMNH).

Distribution. Only known from the type material and the lots listed above; 28-36°N, Mid- and both sides of the Atlantic (but not the coast of Europe) in ca 160-925 m depth.

Redescription.

Shell (figures 1-2). (McLean & Haszprunar's description of the shell is adequate, but some additions are obvious from our much larger material.) In fresh specimens the shell is colourless and translucent. The two radial ribs on the type specimens are individual variations. The shell is

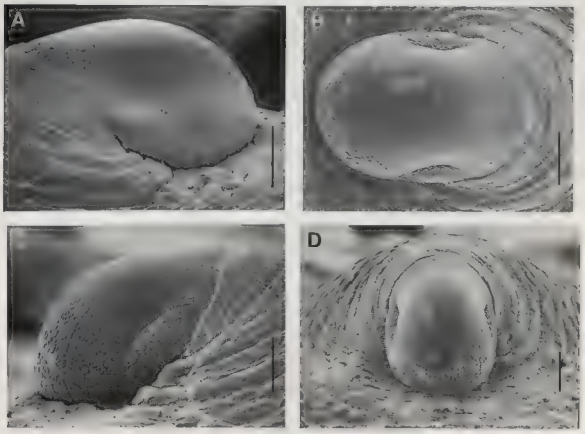

Figure 2A-D. *Kaiparapelta askewi*, Seamount II, DW274, protoconch. Scale lines 50 μm

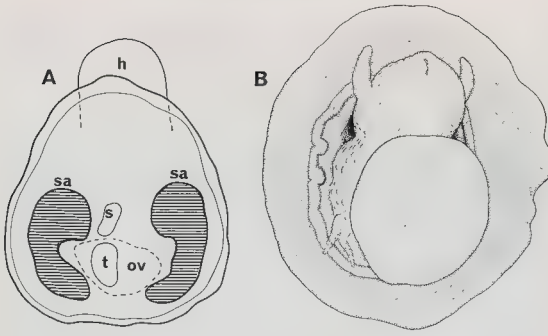

Figure 3A-B *Kaiparapelta askevi*, Seamount II, DW274. A. Dorsal view of body: h, head, ov, ovary, s, masses of sperm; sa, shell muscles; t, testis. B. Ventral view of living specimen.

highly variable and it often takes shape after the substrate (figure 1). Distorted and malformed specimens are common. We show a range of specimens to exemplify this. Large old specimens have a more sturdy shell and may have very distinct muscle scars, especially from what seems to be the cephalic retractor muscles (figure 1B, D). The protoconch (figure 2A-D) is of typical pseudococculinid type, mainly sculptured with irregularly shaped tubercles, some of them fused to form a spiral pattern. The smooth central part in our pictures is probably a result of wear because in live taken specimens it is less pronounced. The maximum size of the teleoconch is ca 5.2 mm diameter (observed on three shells from Atlantis Bank, Seamount 2 DW 174).

Soft parts (figures 3-5). The soft parts are colourless, except the pallial margin. The head is very large, half the size of the foot, with two short and cylindrical tentacles of equal size and shape, and equipped with sensory papillae. The right cephalic tentacle has a furrow which probably is a sperm gutter. The mouth is narrow, T-shaped and surprisingly small. Anteriorly it has a serrated edge, posteriorly the ventral side of the snout is strongly wrinkled. The buccal mass is not visible dorsally through the snout. There is no trace of eyes. The foot is circular and the edge of the foot is surrounded by an indistinct furrow. The ventral surface of the foot (figure 4A) is covered by a thick layer of mucus and small, 10-25 µm long, cylindrical rodlets, possibly bacteria. Close to the apical part of the shell muscle is one rather broad "epipodial" tentacle at each side (figure 5B), at the posterior third, with a smaller, posteriorly situated apical digit. There are two shell muscles (figure 3A), bilaterally symmetrical, kidney-shaped, each covering about 75° of the circle formed by the shell. Posteriorly they are separated by a distance corresponding to 1/10 of the maximum diameter of the shell. In a lateral view of the foot, it can be seen that each shell muscle consists of at least four separate abutting bundles of muscle fibres. In living specimens the pallial margin is crimson and conspicuous, also through the transparent shell. It is rather smooth and consists of three folds. The gill (figure 5A, C) consists of a series of about 12 small, richly ciliated lamellae, about 2.5 times as long as broad and high, in the right pallial furrow. They are placed obliquely across the furrow, more over at the skirt than in the pedal part of the furrow. The occurrence of sensory bursicles could not be verified. The drawn specimen seemed to lack the gill.

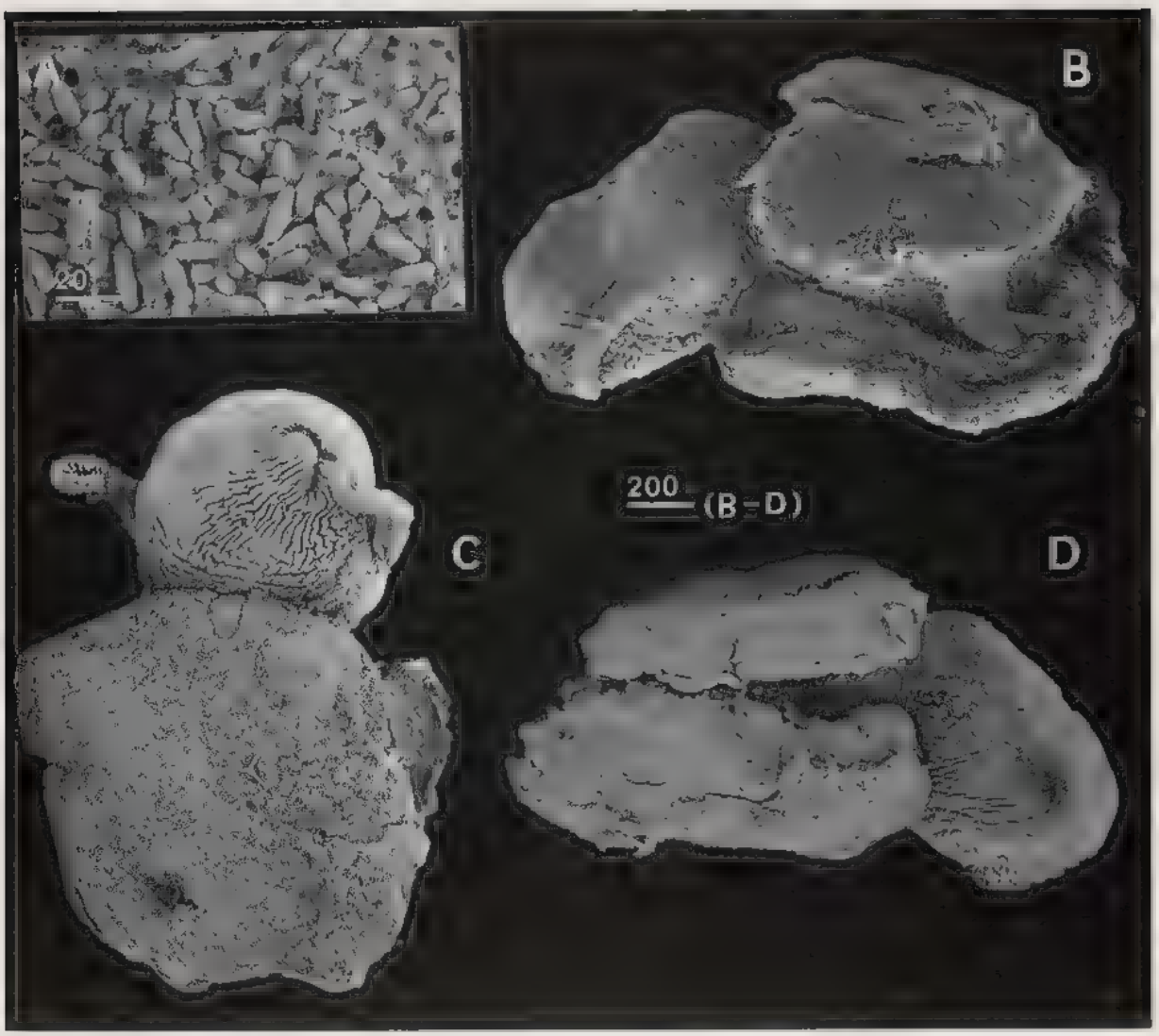

Figure 4A-D *Kaiparapelta askewi*, critical point dried A. Detail of mucus layer of foot B. Left side, pallial skirt removed. C. Ventral view. D Right side. Scale lines in µm.

Staining the body with carm-alum revealed the testis, just behind the apex of the shell (figure 3A). Straight in front of the testis is a more massive mass of sperm.

Radula (figures 5D, 6). The radula is rather large, 1.4 x 1.0 mm and has about 300 transverse rows of teeth, each row consisting of about 280 uniformly shaped teeth. The central tooth is simple, T-shaped in cross-section, bilaterally symmetrical with three apical cusps of equal size. The lateral-marginal teeth are laminar, have a basal attachement area, and a posteriorly directed, vertical comb of 6-15 cusps, the higher number in the centre, the lower at the margin.

Jaws absent.

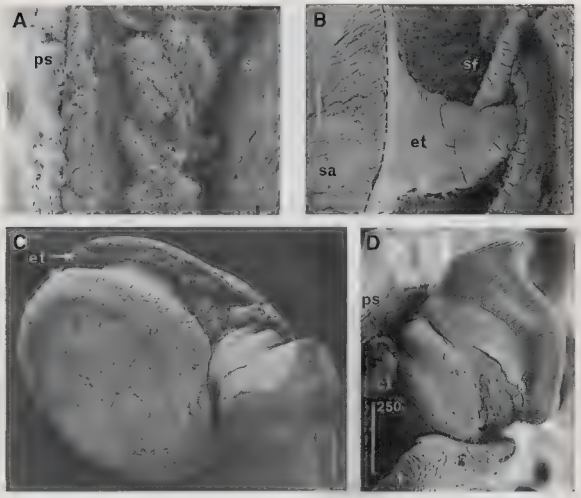

Figure 5A-D. *Kaiparapelta askewi*, critical point dried A Detail of gill B Pallial tentacle from specimen in figure 6B, dorsal view Pallial skirt removed along dashed line C Whole animal, to show gill. D. Lateral view of head with everted buccal mass sa, shell muscle ct - cephalic tentacle, et - epipodial tentacle, f - foot, ps - pallial skirt; sa - shell muscle; sf - side of foot; Scale lines in µm.

Remarks

Kaiparapelta askewi was found on the sponge *Pachastrella monilifera*, a large species forming irregularly shaped masses and easily reaching half a meter in diameter. The growth is very irregular with overhangs and shelves and the mass is penetrated by cracks and crevices. The cortex is very hard. *Kaiparapelta* lives in shallow pits in much larger cavities, where it evidently is sitting quite protected. It is well visible on the sponge as small bright red circles (from the pallial margin). Without this it should have been almost impossible to see. We have not examined the stomach contents, but it seems very likely that it feeds on the sponge and makes its own little "homes". If, as we guess, the rodlets in the mucus between the foot and the sponge are bacteria, it is possible that also these are involved in the process.

We have not found *Kaiparapelta* in any of the numerous dredgings from the European and North African coastal areas despite that we have examined large quantities of material from the Portugese, Spanish and Moroccan coasts east of the Canary Islands and the Lusitanian sea mounts.

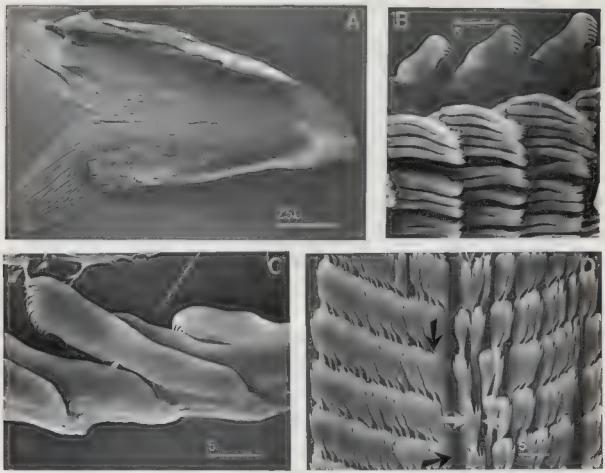

Figure 6A-D *Kaiparapelta askewi*, radula A Complete radula B Outer edge of radula C Individual teeth close to centre. D Detail of central part Tricuspidate central tooth between two horizontal, white arrows Notice also the length of the teeth, between the black arrows. Scale lines in µm

In one critical point dried specimen the whole foot is surrounded by a distinct ridge (figure 4B) halfway between the ventral margin and the pallial skirt, but no trace of this could be seen of this when it was alive, nor in the other specimen, and it seems to be an artifact caused by contraction and preservation.

The gill was not observed in the drawn specimen, but we can not exclude that the the development is individually variable.

We could see sperm masses in the preserved specimens (Fig. 3A), but it could not be ascertained whether they were contained in a receptaculum or a vesicula seminalis. Neither could we determine whether the testis is part of the underlaying ovary or separate.

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Dr O. Tendal, Copenhagen, identified the sponge on which *Kaiparapelta* was found. We thank Drs B A Marshall, Wellington and J H. McLean, Los Angeles who read and commented the paper C Hammar, SMNH prepared all prints for the plates.

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